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Architecture of Kensico Dam

By Alfred D. Flinn*

Of New York's great Catskill aqueduct, now nearly completed, most structures are underground or else they appear simply as long mounds of earth punctuated by occasional buildings, housing sluice gates or other apparatus. When the works are finished, there will be but little visible manifestation of the magnitude of the project. Olive Bridge dam, which restrains Esopus Creek in Ashokan reservoir, is impressive by its bulk of masonry and earth, but did not lend itself naturally to architectural composition. Furthermore, it is remote from the city—a hundred miles away. One structure, however, by its size, its proximity to the city and to lines of travel, its setting and its character, was early recognized as suitable to be made expressive of the dignity and the strength of the whole system—Kensico masonry dam, one of the notably large masses of masonry in the world.

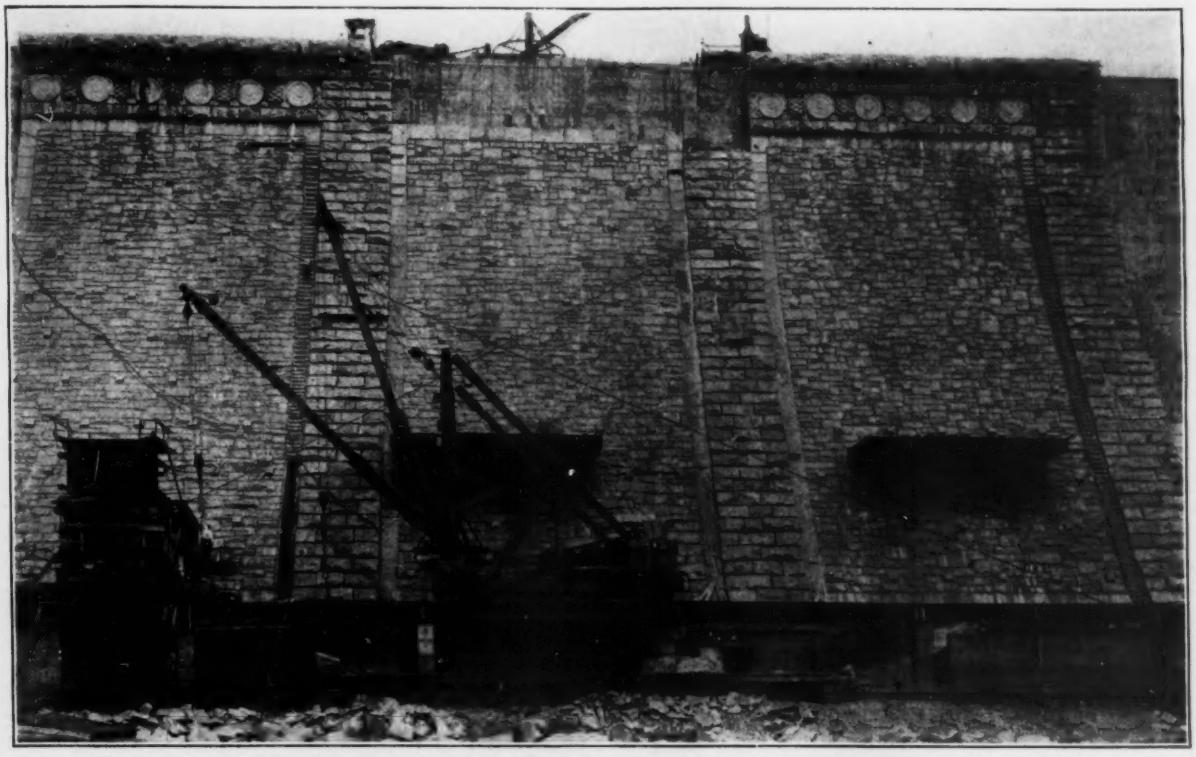

FIG. 1. PART OF DOWNSTREAM FACE OF KENSICO DAM, NEW YORK CITY BOARD OF WATER SUPPLY

Kensico dam is only 13 mi. from New York City's northern boundary line, at the terminus of the Bronx River parkway, which extends northward from one of the city's largest parks, and is within a few hundred feet of a four-track suburban railway. Highways cross it, pass in front of it and extend by both its ends. It is easily accessible. This dam is 1850 ft. long on top and has an exposed height of 133 ft. for a length of 1025 ft. It is divided by contraction and expansion joints into 21 parts each approximately 79 ft. long, and two terminal structures. It contains nearly a million cubic yards of masonry. Its maximum total height is 310 ft.

Selection of Architect

Treatment of Kensico dam as the conspicuous expression of the importance and grandeur of the greatest municipal water-supply system ever undertaken, and not merely as a utilitarian wall for retaining water, puts it partially into the field of architecture. Therefore the Board of Water Supply directed that the requisite services should be secured. As there was much other architectural work to be done, an architect was appointed on the staff of the chief engineer and given a small corps

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of designers and draftsmen. To aid him it was decided to engage the services of a consultant to be selected from among New York's most eminent architects. The method of selecting the consulting architect was unique. Experience elsewhere indicated that the usual competition, based upon submitted drawings, would not do. Instead, the following steps were taken: First, from the many competent architects in New York City a preliminary list of 25 was selected (individuals and partnerships), any one of whom was considered able to furnish advice of the character desired. By careful inquiry, and by examination of some of the structures built by these architects and of drawings and photographs of structures too remote to visit or not yet built, this list was reduced to six. From this short list a final selection was made by the aid of personal conferences, of more detailed examination of work done and of the styles of the several parties. Advice was confidentially sought, also, from a few of the older leaders of the profession. This final selection was made by the chief engineer, and on his recommendation appointment was made by the board.

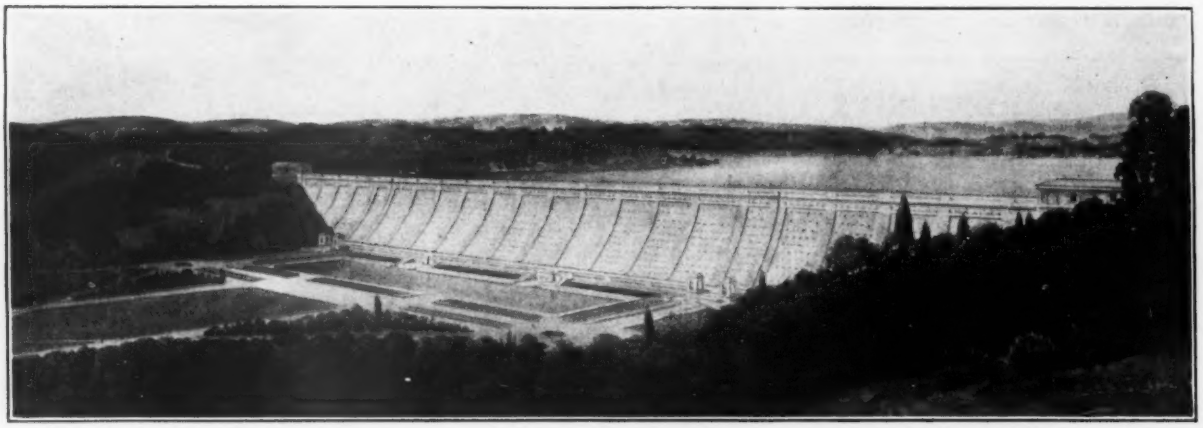

FIG. 2. WASH DRAWING SHOWING KENSICO DAM AS IT WILL LOOK WHEN COMPLETED

General Architectural Treatment

After visiting a number of masonry dams, the architects remarked that all these dams lacked a definite, visible base, that few had satisfactory cornices or entablatures, that architectural composition had been neglected, and that in most of these structures there was little to give scale—no feature of readily appreciated size with which the beholder could measure the main structure and gain some adequate apprehension of its magnitude. Architecturally, then, the problem of Kensico dam may be stated as the securing by means of suitable composition and embellishment of an adequate expression of the strength, magnitude, importance and dignity of this great mass of masonry, and the water-supply system of which it is a part, in harmony with its purpose and its elemental structural character.

To indicate the solution of this problem is the aim of the following paragraphs and the accompanying illustrations. However, a just appreciation of the architects' work will be possible only several years hence, when the dam and its surroundings will have been completed and sufficient time will have elapsed for the trees and other planting to have grown sufficiently to perform their functions in the whole composition.

The long, lofty, straight, level line of the dam's top as viewed from downstream, the equal of which is not to be found in any other kind of masonry structure, has been preserved unbroken, but is strongly terminated by massive circular pavilions of cut granite, which will serve also as shelters for visitors. Between the pavilions extend stone parapets of very simple design, about 3 ft. high, bounding the roadway. From these pavilions beautiful views can be enjoyed across the reservoir and the surrounding hill country. In the base of each pavilion storage space is available for tools and materials. On the upstream side of the dam steps and ramps lead down to the water surface from these pavilions. The roadway on top of the dam is to be paved with vitrified brick blocks.

For a base in the architectural composition of the downstream face of the dam a paved, level terrace has been provided, 30 ft. wide and 1025 ft. long across the valley bottom, and continued up the hill slopes by ramps 20 ft. wide terminating at the circular pavilions marking the ends of the top of the dam. The terrace pavement is 10 ft. above the ground immediately in front of it and is supported by a massive cut-stone wall. Beneath the terrace are a valve chamber and storage spaces. The downstream face of the dam is naturally divided into three parts—the central portion of uniform height and two triangular wings on the hillsides. This division is emphasized architecturally by placing a pylon at each end of the central portion, with two small square pavilions at the foot of each pylon, on the terrace, and steps leading down to the ground level, between these pavilions.

Since the contraction joints are an evident structural feature, they were made also a dominant motif in the architectural composition, as will be at once observed when looking at the dam or pictures of it (see Fig. 2). A broad, rusticated band of large, very roughly cut stones marks one edge of each contraction joint. The space between adjacent bands naturally becomes a panel, bounded top and bottom by the entablature and the base, or terrace. Around the margin of each panel is a narrow border of relatively smoothly cut stones, while the field is composed of "roughly squared" stone masonry, relieved and controlled by square cut-stone headers projecting slightly and arranged in a diamond pattern. One notable characteristic of the masonry facing is the coarse-

ness and simplicity of the stone cutting; another is the very large size of many of the stones, and the third is the strong color contrasts in the stone.

In the torus of the entablature all stones are 4 ft. high; many are 5 to 8 ft. long, and weigh 9 to 14 tons each. The frieze is 6 ft. 6 in. high, in one course, and most of its stones weigh 10 to 14 tons or more. Only sufficient carving of the crudest sort has been done on these frieze stones to develop the very simple design. At the bottom of each rusticated band is a kneeler made up of five stones, weighing together 51 tons. In the panel fields no stones have exposed faces less than ½ sq.ft. in area, and at least 50 per cent. of the exposed face of the roughly squared stone masonry in the dam consists of stones each having a face area greater than 6 sq.ft. In general, as many stones as possible are as large as it is practicable to handle. To give further boldness and suggestion of strength to the masonry, most fully taken advantage, although in so doing they have sturdily disregarded the older conceptions of good engineering masonry, for which it was commonly specified that the stone should be uniform in color and texture and in which very narrow joints were regarded as necessary. Structural convenience led to building the heart of the dam and its upstream concrete block face to full height before setting the stone masonry on the downstream face. To receive the stone facing the heart masonry was built in steps graduated to the heights of the stone courses and the face stones set in cement mortar into the steps so formed. This building the dam proper before the face work was started permitted an organization of the current season's work focused upon stone masonry which has secured remarkable progress in keeping with the record-breaking rate at which the cyclopean masonry was placed last year. Incidentally, the hoisting of large numbers of dripping buckets of con-

FIG. 3. NEAR VIEW OF ENTABLATURE AND PANEL OF DOWNSTREAM FACE OF KENSICO DAM

of the joints are wide and are recessed. The struggle has been to secure a general surface texture which would not seem too smooth and flat, and consequently uninteresting when beheld from a point remote enough to afford a comprehensive view.

Variety of Stone

Fortunately, the local gneissoid granite, which for economic reasons was used for the concrete and cyclopean masonry, proved to be a beautiful stone for the architectural features. Its grain varies from that of a straight-banded gneiss through curly and knotted varieties to that of a true, massive granite. Large pegmatite intrusions are frequent. In color the range is from light gray to strong pink, with green, black and white streaks and areas, due to different mineralogical ingredients, and deep russets and browns on seam faces. Of all these characters of the stone the architects have skillcrete over the lower portions of completed face masonry is being avoided; also the disfigurement resulting therefrom so common heretofore in dam building and so seldom wholly cured by the cleaning-down.

Forecourt Treatment

To provide room for the large pit for the foundation of the dam, the disposal of surplus excavated materials, the concrete blockyard and portions of the construction plant and camp, an extensive area of land was purchased downstream from the dam line. In the landscape and architectural scheme this area is being utilized as a foreground for the dam. Its conspicuous features are the pools, the main one having a water surface 720 ft. long by 135 ft. wide, paralleling the terrace and 50 ft. therefrom, with two smaller pools, 35 by 180 ft., at its ends; the fountains, and the broad avenues leading to the dam and affording vistas of important parts.

Models were necessary as aids to the determination of many important architectural questions. Besides small-scale plaster models of the whole dam and larger-scale models of portions of the dam, also in plaster, two full-size stone models of a portion of the entablature and of the panel and rusticated band beneath were made and modified until satisfactory proportions and textures were secured. These stone models were built by the contractor near the dam, under provisions of the contract, and the final, approved model has been preserved for the guidance of the stonecutters and masons as well as of the engineers and inspectors.

But few masonry dams in this country have had their visible portions designed in toto as architectural structures, and but few have been so situated or of such importance as to merit or need it. The problem is a very unusual one for an architect, but the solution adopted for Kensico dam proves that masonry dams need not be ugly and that architectural treatment can harmonize with the structural character.

Elements in Design

There appear, therefore, as original elements in the architectural design of this dam: (1) The division of the wall into panels by bands of rusticated stone indicating the contraction, or expansion, joints; (2) the substitution of an adequate treatment for the usual "cornices"; (3) the provision of a base and ramps which receive the flanking hills; (4) the introduction of smaller structures, treated as integral parts of the design of the dam; (5) the pools, or artificial water, below the dam; (6) the foreground layout which also is connected intimately with the design of the wall itself; and (7) the planting of this foreground in such a manner as to give the best effect and to require the least expense to maintain.

Architects, Engineers and Contractors

The staff architect of the Board of Water Supply is H. Lincoln Rogers; York & Sawyer are the consulting architects; Charles W. Leavitt, Jr., was consulted on landscape design. All this work has been done under the supervision of J. Waldo Smith, Chief Engineer of the Board. The engineering designs were prepared under the direction of the writer and later of Thaddeus Merriman, as department engineers of headquarters department, by Designing Engineers Charles E. Gregory and Fred. F. Moore. Fred E. Winsor has had general charge of construction, as Department Engineer of the Southern Aqueduct department; Wilson Fitch Smith has been Division Engineer in charge of Kensico reservoir, and, as Section Engineer, Edwin L. Sprague, Jr., has had immediate charge of the building of the dam. For the contractor, H. S. Kerbaugh, Inc., Beverly R. Value, as engineer, and George Angel, as superintendent, have given hearty coöperation in carrying out the spirit of the architectural design and accomplishing a satisfactory result.

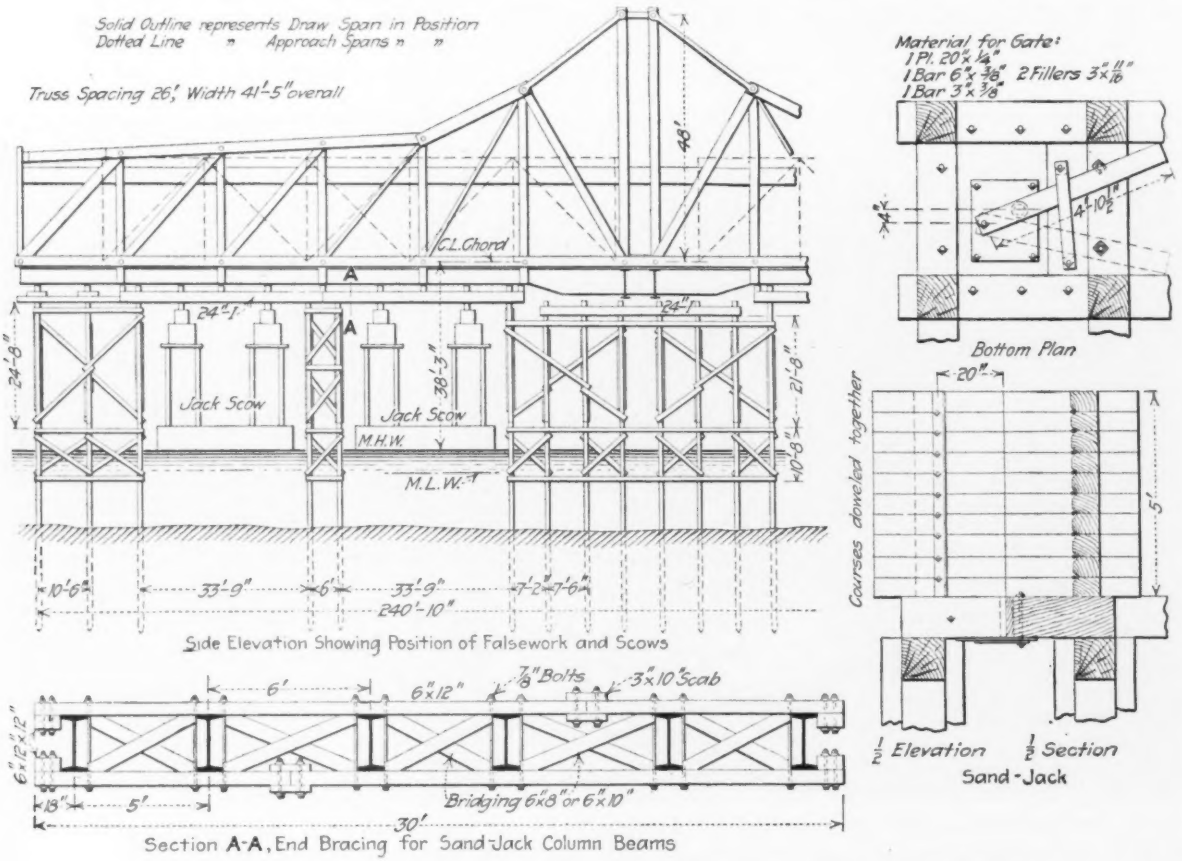

FIG. 1. FALSEWORK, SCOWS AND SAND-JACKS FOR FOUR-TRACK SWINGBRIDGE

Harlem River draw of elevated railway, Interborough Rapid Transit Co., New York. Floated into place Sunday, Aug. 29, 1915

Double-Deck Swingbridge Floated in Place

The double-track swing-span of the Interborough Rapid Transit Co. which carries the Third and Second Ave. elevated railways across the Harlem River at 129th St., New York City, was replaced on the morning of Sunday, Aug. 22, 1915, by a new span carrying four tracks on two decks. It had been built on falsework along the river bank close by, the falsework being so laid out as to admit scows for lifting the span off and moving it to the bridge site. The span was practically completed by June 1, and June 6 was originally scheduled for the moving. The center-pier masonry had been prepared to receive the new center support and was also in readiness. But it was found desirable to make changes in the operating machinery of the span, and the moving was therefore postponed.

The floating was done by the tidal rise (about 4½ ft.). The old span weighed 500 tons, and the new span 1100 tons. Scows about 30x95 ft. were used, two for the old span and four for the new, requiring in both cases about 3 ft. immersion to take the weight. By floating the old span and the new one simultaneously, the operation was done in one tide, so far as interrupting railway and river traffic was concerned, though the preceding tide was used to float the new span off its falsework and get it ready on the scows.

Scows were put under the new span the middle of the afternoon of Aug. 21. The rise of the tide lagged somewhat behind the expected curve on account of the east wind. The span lifted off near 6 p.m., and was pulled off the falsework and moored near by. At low tide, 2 a.m. Sunday, Aug. 22, the two scows for the old span were floated into position and the span blocked up on them. The scows were then jacked down about a foot (the blocking being arranged for jacks) in order to get the span free early enough to prepare the new bearings by flood tide. The old span was rim-bearing, and its spider and center casting had to be removed. The spider exceeded in weight the available derrick capacity, and had to be burned apart into quarters by oxygen flame, causing the loss of some time. The new center casting and the base castings of the side wedges were set on previously prepared beds. The old span had floated off by 6 a.m.; at 8 a.m., flood-tide, the new span was brought along by tugs and put into exact position by mooring-lines and by tackle at the ends. It was seated on 24 sand-jacks, six on each scow. They were lowered in 3-in. stages, and worked easily and smoothly.

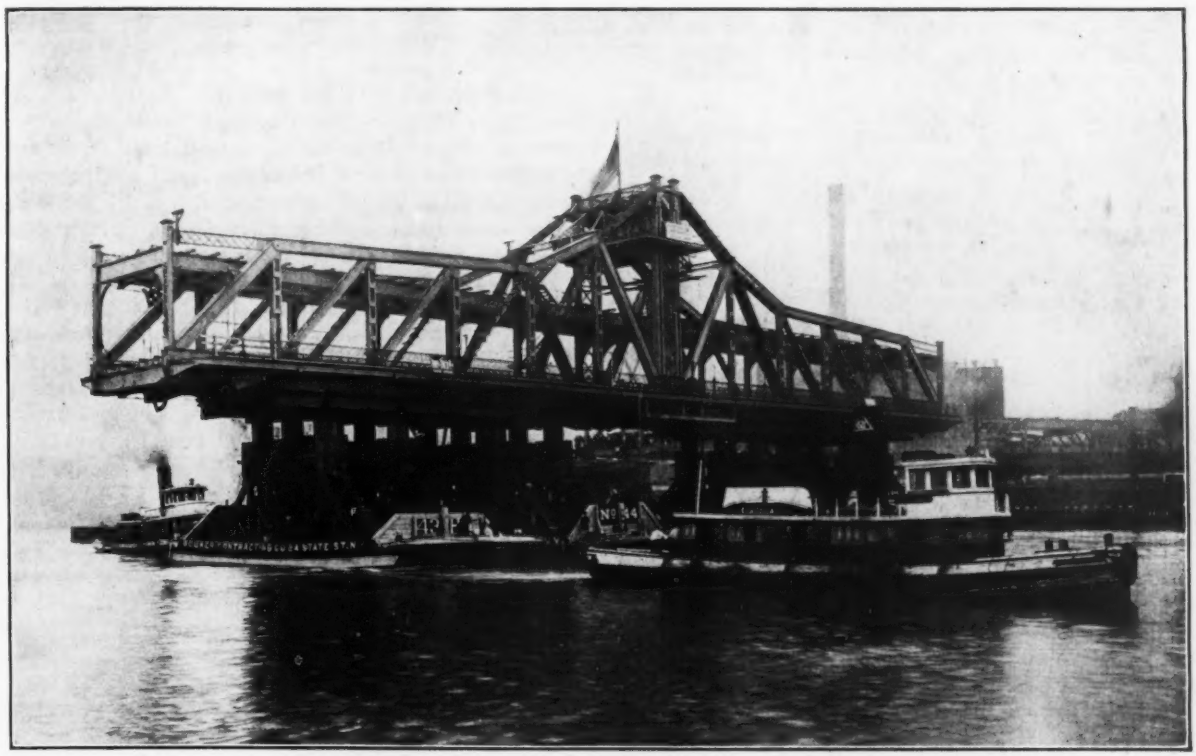

FIG. 2. NEW SWINGBRIDGE BEING FLOATED IN

View looking north. Center pier is back of left-hand scow. Bronx rest-pier shows under middle of draw. Note timber stiffening of eyebar diagonals and top-chord members

The sand-jack boxes were 39 in. square inside, built of courses of 8x8s solid, tied together in each course by bolts ample for full hydrostatic pressure. In the bottom was a 4-in. hole, closed below by a cutoff gate made of a 6x⅜-in. steel bar (see sketch in Fig. 1).

The span came to bearing on the center support at 10 o'clock. After further lowering of the jacks to reduce the buoyancy of the scows, the end and center wedges were driven, and the eight balancing wheels adjusted to bearing on the track. The first train passed over the bridge shortly before 1 p.m. Sunday.

Terry & Tench, Inc., did the work, with Holton D. Robinson as engineer and Wade L. Cline as superintendent. For the Interborough Rapid Transit Co., George H. Pegram, chief engineer, F. W. Gardiner, principal assistant engineer, S. Johannesson, designing engineer, and B. O'Rourke, resident engineer, were active.

Coast Erosion and Protection on Long Island and New Jersey--III

By Gerald O. Case*

SYNOPSIS—Failure of high groins and vertical bulkheads as coast protection works. Proper method of design and construction of low groins, which have proved successful. Application to construction in New Jersey and Long Island.

Coast Protection Work

Residents along the sea coast and others who have observed the great amount of damage done during gales and the enormous destructive power of waves often have the idea that works to prevent coast erosion must necessarily be very strong and designed to oppose the forces of nature. To fight against the destructive forces of the sea is a very costly business and the chances of success are very small. The sea has, however, a constructive as well as a destructive power, and if we utilize the constructive power, instead of opposing the destructive power, it is in most cases possible to prevent erosion and in many cases to do so by very simple and inexpensive means.

Broadly speaking, coast-protection works may be considered as falling under one of two heads, either "passive" or "active" defenses. In the first group the chief aim is to increase the resisting power of the natural barrier or cliff against the sea, by substituting a harder and more durable material for that already existing, or by increasing the size and height of the natural barrier, thus providing a greater factor of safety. Seawalls, bulkheads and artifically created littoral sand dunes are examples belonging to the first division. Under certain circumstances groins may also be put in for the sole purpose of holding the existing material on the shore and preventing further loss; but as a rule they have a much wider use and come under the head of active defenses.

Disadvantages of Seawalls

In the passive types of protection works—seawalls, bulkheads, etc.—the difficulty is to get the advantage of the passive resistance without at the same time introducing some new factor which exercises a deleterious influence. That such a factor may be introduced is too often to be seen on the New Jersey and Long Island coasts, where many of the vertical or nearly vertical bulkheads have caused erosion, often so serious as to far outweigh any good effects they might have.

Where erosion of the foreshore is taking place due to wave and current action, seawalls or bulkheads cannot in any way prevent its continuance. All they will do is to postpone the erosion of the mainland. If, for example, a bulkhead is constructed at high-water line on a shore which is being eroded by the alongshore movement of sand or shingle which is not compensated for by material moved in from the windward side, then after the bulkhead is completed, even if it does not itself injuriously effect the foreshore, the erosion due to littoral drift will still go on; the water at the toe of the bulkhead will gradually get deeper and deeper until the structure is undermined and collapses. We are therefore driven to the conclusion that seawalls and bulkheads constructed on a shore which is being eroded by wave and current action are doomed to destruction if the erosion continues, unless they are themselves protected by a natural barrier of beach or sand kept in place by groins or other means. If, therefore, a barrier of sand or shingle is necessary in front of a wall or bulkhead, what are the uses of these structures? Their only uses are to protect valuable property while the groins are building up a barrier of sand or shingle, and after that has been accomplished are of advantage as a temporary protection in case the barrier of sand or shingle is suddenly scoured away, due to a breakdown in the groins or other cause. In that event, however, it will be necessary as soon as possible to build up the shore again in front of the wall or bulkhead.

Seawalls or bulkheads should never be put in to protect agricultural land and should only be constructed in front of valuable building land, where it is absolutely necessary to preserve the high-water line while the groins are doing their work. It is expensive to build a wall or bulkhead which will not itself cause scour, and the existence of either makes it more difficult and expensive to collect the protecting barrier of sand; more groins being, as a rule, required than would be necessary if the wall was not there.

Wave Screens of Little Value

Many attempts have been made to prevent erosion by reducing the violence of the attack by constructing wave screens, but they have met with little success, and this is not to be wondered at when the enormous force of wave impact is considered, amounting as it does sometimes to 2 or 3 tons per sq.ft. If a permeable screen is erected, then if the spaces are too large the waves are not checked sufficiently to do any appreciable good, and if they are small the cost of the structure is prohibitive if it is successfully to withstand the force of the waves.

At Seabright, N. J., and other places, some of the bulkheads are "protected" by rows of piling set some distance out in the sea, with the object of breaking the forces of the oncoming waves. The storms of the past two winters plainly showed that if the piles are sufficiently close together to protect the beach; they are quickly demolished; but if the space between the piles is large enough to enable the screen to withstand storms, then the waves pass through with sufficient force to destroy the bulkheads. In several instances houses which were protected by bulkheads and wave screens, were wrecked by the waves passing through the screens, destroying the bulkheads and then undermining the houses.

Breakwaters Too Expensive

The accumulation which, under natural conditions, takes place between an outlying island and the mainland, or between a wreck near low-water mark and the coastline, suggests a means of coast protection. There is no doubt that if it were possible to build a cheap and lasting structure seaward of low-water line, which would protect the shore behind it from oblique wind waves, it would form

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a very effective protection and cause accretion of the shore to take place. It must, however, be remembered that to protect the shore from wave action a very strong structure is necessary if it is to be lasting. A breakwater such as is built to protect harbors in deep water would no doubt be a very effective protection against coast erosion if built some distance seaward of low-water line parallel to the shore, but its cost is prohibitive and, moreover, unnecessary, as protection can be effected at a very reasonable cost by a proper system of low groining.

If built in shallow water subject to wave and current action during storms, a protection work built parallel to the shore is subject to considerable erosion on the sea face. In the case of an outlying island it is always found that the sea side is subject to erosion, and that while accretion takes place between the island and the mainland, erosion of the exposed side of the island generally goes on at a rapid rate.

Value of Sand Dunes

Where localized erosion is caused on the leeward side of headlands, river outlets or other obstructions to the littoral drift, little or no material may be available with which to build up the foreshore. In such cases long low groins may be usefully constructed for the purpose of holding the material already there and preventing further loss. If there is a cliff at high-water mark, the erosion will stop if we prevent material being moved away from the base, as the continued erosion is dependent on the waves and currents moving away the débris eroded by direct wave impact. The loss of fine material, clay, etc., cannot be prevented; but if we stop the movement of sand and shingle, then there will be a sort of automatic protection by the sea against itself due to the formation of a bank of material at the base of the cliff.

Where erosion is due to the formation and inland movement of sand dunes, it can be prevented by collecting the inblown sand a short distance back from high-water line, and the formation of a littoral coast protection dune, which, when built up by the wind, under the guidance of man to a proper height and inclination, serves several useful purposes. In the first place, such a littoral dune prevents inland sand drift and the formation of sand wastes; secondly, it acts as an embankment or second line of defense against coast erosion; and, thirdly, it enables the reclamation of any existing areas of bare sand behind the littoral dune. Where a large littoral dune is formed, which prevents the inland movement of sand, the tendency is for land to be gained from the sea by the gradual formation of small irregular-shaped dunes in front of the protection dune.

Use of Vegetation

Vegetation plays a very important part in preventing coast erosion, by building up, binding and consolidating natural or artificially formed littoral dunes, and enables them to be of service as a barrier or second line of defense in case of gales at exceptionally high tides. If covered by vegetation a littoral dune forms a very effective sea embankment. The roots of the various grasses bind the sand surface and the foliage catches sand blown in, the vegetation being able to accommodate itself to a slowly rising surface level.

By sand binding grasses, with stems bending to the elements, and deep, wide roots binding the sand together in a network of strong fibers, Holland largely holds the land she has wrested from the sea. That fair, fertile, rich province, the peninsula of Eiderstadt, in the south of Friesland, has on the point toward the sea only a short row of dunes—some 6 mi. long; but the people talk of their fringe of sand hills as if it were a border set with pearls. They look upon it as their best protection against Neptune.

While sand-dune embankments, when raised to a proper height and slope and fixed by vegetation, are undoubtedly a very cheap and effective means of preventing erosion by the inland movement of dunes and form a valuable second line of defense, such embankments will not, however, withstand some damage by waves during high tides and gales. They require constant attention, and it is necessary immediately to repair, by collecting fresh sand and replanting where necessary, any breach formed.

Where erosion, due to the movement of littoral drift, caused by wave and current action, is taking place on the foreshore in front of the dunes, it is essential to stop it by groining; otherwise in course of time the littoral dune will inevitably be undermined.

Long Low Groins Best Protection

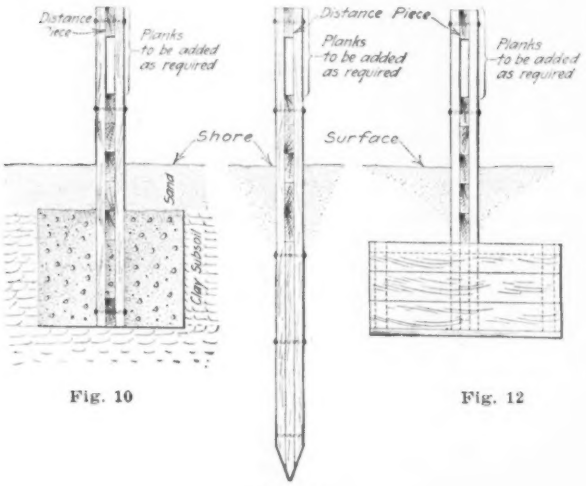
Where the erosion of the New Jersey and Long Island coasts is taking place and being actively aided by high groins and vertical or nearly vertical bulkheads, it would be necessary to cut down or otherwise modify these structures before any successful protection works can be built at a reasonable cost. The keynote of success is, firstly, never to build any structure which offers a large surface to direct wave blow, and, secondly, to utilize the constructive forces of the sea to build up a natural protecting barrier of sand or shingle up which the waves can harmlessly roll and gradually expend their energy before reaching high-water mark. This can only be accomplished by long low adjustable groins gradually built up as the shore is added to by accretion. Wherever high groins or jetties exist, they should be cut down so that not more than about 2 ft. of groin projects above the shore. Where there are vertical or nearly vertical sea walls or bulkheads, which have more than 2 ft. exposed to wave impact at high tides, then an outer row or rows of timber or concrete piling or other construction must be put in so as to form a stepped wall, no step to be more than 2 ft. high above the one below. In this way the energy of the waves will be gradually diminished as each step is encountered, and the backwash instead of rushing down with gradually accelerated velocity, will, as it pours from step to step, have its velocity destroyed.

Action of Groins

Coast protection by means of groins is of very ancient origin, dating back certainly 300 years; but, strange to say, until quite recent years very little, if any, advance was made in the methods of applying them.

Groins can accumulate material in two ways—either by trapping sand or shingle moved along the bottom or by slowing down the littoral currents and thus cause them to deposit material held in suspension. To trap material moved along the bottom appears to have been until recent years the sole reason for erecting groins; but a very large amount of sand is churned up by wave action and carried along in suspension by oblique waves and wind-formed and tidal currents. A groin should, therefore, be designed to slow down the littoral currents as well as collect material moved along the bottom.

While almost any obstruction built across the foreshore will suffice to collect shingle, the same is not true for sand. If, therefore, we erect a groin suitable for collecting sand, we may be sure that it will also catch and retain shingle; but the converse of this is by no means true. Groins should not be built so as to entirely stop the littoral or alongshore currents, but built so as to permit them to flow, bearing their burden of suspended sand,



FIGS. 10 TO 12. THREE TYPES OF TIMBER GROINS

and check their velocity, and thus cause them to deposit material in the proper place.

In designing groins for collecting sand care must be taken to see that their effect is not to divert the alongshore currents in a seaward direction, either by making them too high or putting them in other than at right angles to the main direction of the flow of the littoral currents.

The action of a groin in accumulating material may also be due to the reflection of oblique waves landward. When an oblique wave strikes a groin, there is a tendency for it to be reflected landward along the groin, and the disturbance due to impact will stir up sand on the bottom and carry it toward the land. There is, no doubt, an escape seaward of the reflected water, but it would naturally not be so concentrated as the currents due to the wave impact on the groin, and so would not be so effective in carrying away such material brought in.

Height of Groins

Before the introduction of the low groin system the general practice was to construct what may be termed "high groins," which commenced at high water and were seldom carried right down to low-water line. They were built up to the full height in the first place, and the tops were usually at an unvarying gradient, being simply inclined in a straight line seaward without any regard to the varying curvature of the foreshore. It is a matter of common observation that, in most cases, where groins are put in exceeding 2 or 3 ft. in height above the shore level irregular accumulation occurs. There is usually no building up of the shore on the leeward side, but actual denudation.

High groins are unnecessarily costly, since they expose a large surface to the sea and must consequently be built very strong. The important thing is to build the groins low, and only raise them as the shore surface is raised. In this way a groin which is technically a low one may eventually, as the shore builds up, be very high, when measured from its foundations; but it should never be high above the shore surface.

Direction and Length of Groins

The efficiency of a groin depends on its ability to intercept drift, which is another way of saying that it depends partly on its effective length—that is, on the distance to which it extends across the littoral currents. It is obvious that for a current flowing parallel to the coast line any departure from the right angle direction means a reduction in efficiency for a given length of groin. On a sandy shore the groin, if put in obliquely and directed away from the side from which the prevalent wind waves come, must have an injurious effect, for not only is there more surface exposed to the wave stroke and a consequently greater liability to scour, caused by the rebound of the waves, but also water flowing down the foreshore from the backwash of the waves is intercepted by the groin, which thus diverts a serious current to one part of the shore. Instead of having the water spread out in a thin layer over the foreshore it is concentrated along the groin, producing a channel down which sand is swept. Any divergence from the right angle direction tends to divert the alongshore currents in a seaward or landward course, which is detrimental to sand accumulation.

On sandy shores oblique groins not only have serious disadvantages compared with right-angle groins, but are

FIG. 13. REINFORCED-CONCRETE CASE GROINS NEAR BRIGHTON, ENGLAND

also more costly, as they are more liable to be damaged by waves and a longer groin is required to extend from high- to low-water line.

On shores where the material is chiefly shingle, and the littoral drift almost entirely due to oblique wind waves moving material along the bottom, groins constructed at or nearly at right angles to the prevalent oblique wind waves are effective in preventing shingle travel; but as most of the shores of New Jersey and Long Island are of a sandy nature it is not necessary to consider their action or the relative advantages of oblique and right-angle groins for preventing shingle travel.

Groins should always extend from high- to low-water line, and, if possible, be extended seaward of low water. The longer the groin, the greater will be its efficiency. The success of submarine groins has been amply proved.

There is usually a large amount of material traveling just seaward of low water, owing to the length of time the tide hangs about this point and to the sea bed being always exposed to the action of currents and waves.

Distance Apart of Groins

The distance apart of groins should not be greater than the distance between high- and low-water lines, and in some cases should be considerably less. If the groins are not built up more than 2 ft. above the shore level, and added to as accretion takes place, they may be placed 200 ft. apart. Provided they are not put in sufficiently close together to cause the formation of an eddy or swirl from one groin to the other, the closer together they are put, the more quickly will the shore be raised. The distance apart, therefore, depends to some extent on the amount of building up which is necessary. If the groins are only required to hold material already there, or to build up the shore to a small extent, they may be put farther apart than in cases where it is necessary rapidly to accrete material in order to prevent serious erosion.

Materials of Construction

In selecting mateials for constructing coast-protection works, durability and high specific gravity are the principal qualities to be sought after. Durability is affected by ordinary decay, erosion by moving sand and stones, chemical action, and exposure to changes of temperature, as well as by the direct blow of the waves and by the destructive action of sea worms.

Many methods have been tried to prevent timber from being destroyed by marine borers. In Holland "teredo nails" are used with fairly satisfactory results. They are flat-headed iron nails driven in close together; on rusting they form an impervious skin over the surface of the timber. Creosoting is the method used in many places to prevent the destruction of timber by the teredo and limnoria. While it undoubtedly preserves the timber to a certain extent, the author has, in numerous places, seen timber impregnated with the maximum amount of creosote possible quickly attacked and eaten by these borers. When creosoted timber is immersed in sea water, the creosote is gradually expelled and its place taken by the salt water; but if there is no soft uncreosoted timber available for the teredo to eat up, they will attack the creosoted timber almost as soon as it is put in.

After many years' practical experience in the design and construction of coast-protection works the author has no hesitation in saying that, as a general rule, reinforced concrete is the best material to use for constructing groins and sea walls. It is more durable than timber and has the advantage of having a higher specific gravity.

Methods of Constructing Groins

The method of constructing the groins to get the best results must be such that the groin can be added to from time to time, as accumulation takes place, and therefore, as a general rule, some form of construction consisting of piles or columns and planks or slabs is the best and cheapest to use.

Figs. 10, 11 and 12 show three methods used for constructing Case timber groins, and Fig. 13 illustrates the construction of reinforced-concrete Case groins near Brighton in England.

For shores where there is a subsoil of clay or other hard material at a reasonable distance under the surface, the practice of fixing the piles by embedding their lower ends in concrete rammed into holes dug in the foreshore is the best possible method and the cheapest. The piles practically become welded into the substratum and in clay, where canting of driven piles is such a common difficulty owing to the small amount of surface exposed, permitting them to force the clay aside. A pile set in concrete gives a better grip to the shore and will not cant or be displaced as easily as a driven pile. The method of construction shown in Fig. 12 has been successfully used on sandy shores where there was no subsoil within a reasonable depth. The method of fixing the planking or slabs is of no special importance, provided that if a single pile is used every plank is firmly fixed to the pile, and in the case of a composite pile that the top plank is rigidly fixed to the pile. The use of the composite pile does away with the necessity of rigidly fixing all the planks and makes it impossible for the lower planks to come off, which often occurs during storms when a single pile is used.

FIGS. 14 AND 15. SHORE AT DEAL, ENGLAND, BEFORE AND AFTER BEING BUILT UP BY GROINS

Care must always be taken to see that the planking is put in sufficiently far below the shore surface to avoid risk of underruns.

If low groins are put in there is no necessity for having struts, which are, of course, essential in the case of high groins. Struts not only add considerably to the cost, but on sandy shores scour often takes place round each strut.

Efficiency of Long Low Groins

Where there is a plentiful supply of material traveling, long low groins cannot fail to collect sand or shingle and build up the shore, if they are properly constructed and put in at the correct distance apart and at the proper angle to the coast line. If the groins are constructed of

timber it is necessary to keep them in a proper state of repair and renew any piles or planks as soon as they are eaten away by the teredo. Reinforced-concrete groins, if properly built in the first place, are practically everlasting, and it is only necessary to add the planking slabs as accumulation takes place.

When the Case system of groining was adopted at Dymchurch, England, in 1894, the seawall, which is about 3 mi. long and protects 60,000 acres of low-lying land from inundation by the sea, was in a very precarious condition, and its upkeep cost an enormous sum of money. Breaches in the wall had to be constantly repaired. The foreshore at that time consisted of wet sand, mud, and pools of water. By 1898 the conditions had so improved that hard sand had taken the place of the mud and pools of water, and from 7 to 8 ft. of sand had in places accumulated near the toe of the wall. Over the whole distance of 3 mi. the shore has on the average been raised 4 ft. 6 in. and the low-water line has been driven seaward about 400 ft.

At Deal, England, between 1872 and 1898 high-water line had advanced 40 ft. and low-water line 160 ft., the Borough Council being constantly obliged to spend large sums of money in repairing the sea wall and promenade road, which in various places were breached by the sea. According to a report made by the borough engineer, a total of 58,878 tons of material was accumulated by the Case groins between 1898 and 1900, and low-water line was driven seaward an average distance of 50 ft.

Formation of Littoral Dunes

When sand moves inland and erosion is due to the inland movement of sand dunes, it is necessary artificially to raise the height of the existing dunes on the coast margin or form a littoral dune. The best place for the littoral dune is about 100 ft. landward of highwater spring tides. The first step to be taken is the erection of a continuous line of paling fencing. This should consist of boards about 6 ft. long by about 6 in. wide and 1 in. thick, the bottom ends being pointed. The planks should be driven about 3 ft. into the sand, a space of 1 in. being left between the planks. Sand transported inland then accumulates on both sides of the fence, and when it has risen to within a few inches of the top of the planks they should be pulled up about 3 ft. This can be accomplished by means of levers and the process repeated until a littoral dune has been built up high enough to prevent sand from being drifted inland. Experience has shown that the height required to prevent inland drift is, as a general rule, about 40 ft. The best slope for the sea face is 7 deg. and for the land face 22 deg. with the horizontal. By altering the position of the fence, or putting in a double row of fencing a few feet apart, the slopes can within certain limits be regulated at will.

When the dune has been built up it should be planted with sand-loving grasses or shrubs on both faces. Sometimes difficulty is experienced in getting the vegetation to grow on the sea face. In that case it may be protected from sand drift while the plants are establishing themselves by putting up a temporary fence on the sea side.

In France tufts of marram grass are planted in wintertime in front of the fences in quinquex order, and between the plants seeds of other grasses are sown. On the sea side of the dune 121 marram plants and 5¼ lb. of grass seed are used to each acre of surface.

The increase in height of the dune will depend on its size; and it is useless to attempt systematic planting until the size of the dune is such that the increase in height of the slopes is not more than 1 ft. per annum. Suitable grasses and shrubs will, by upgrowth, adjust themselves to a surface level which is rising at this rate.

In places where the foreshore has become lowered in front of the dune by littoral drift and where the supply of inblown sand has practically ceased for some reason, the dune face will be exposed to wind action, salt spray and wave action during storms and very high tides, and in such situations it is difficult for the vegetation to grow on the lower part of the sea face. To protect the dunes while groins are building up the foreshore again an artificial facing of fascines or reinforced concrete is often used in Holland on the lower part of the dune slope just above high-water line.

Protection Works on the New Jersey Coast

The coast-protection works constructed on the New Jersey coast have, on the whole, met with little success, although vast sums of money have been spent in constructing groins or jetties and bulkheads. Many of the works put up are striking examples of the futility of combating the waves and currents. Instead of protecting the coast, many of the works are most efficient coast eroders and splendid examples of how not to construct coast-protection works. The money spent has unfortunately been more than wasted, since the failures have, in a large degree, hindered the adoption of other plans, based on wider experience. Most of the systems adopted are very similar and consist of pile groins filled with brush and stone, usually built up 4 or 5 ft. above the shore surface. A certain amount of accumulation takes place on the windward side and considerable erosion on the leeward side. If the property is valuable and the erosion continues—as it usually does—a vertical, or nearly vertical, bulkhead is constructed a little back from high water and parallel to the shore line. These works cost from $15 to $50 per ft. run of frontage. The erosion still goes on and in course of time the bulkhead is destroyed. The houses in front are then moved back and the same process begins all over again.[11]

The reasons for the general failure of the works are: Firstly, the groins are built too high, are not long enough and have not the proper slope; secondly, the vertical or nearly vertical bulkheads greatly assist the erosion; thirdly, proper steps have not been taken to prevent the inland movement of the sand spits and sand islands.

After many years' experience in designing coast works on all kinds of shores, the author is firmly of the opinion that the New Jersey coast could be permanently protected at a moderate cost by constructing a comprehensive system of long, low, reinforced-concrete groins, extending out to and beyond low-water line, modifying the existing jetties by cutting them down and, where they are essential, forming the bulkheads into stepped sea walls, and lastly by raising and planting where necessary the natural sand embankments or forming a littoral dune to prevent the inland movement of the sand spits and sand islands.

It is probable that the cost of permanent works would be little more than the cost of constructing the timber groins and bulkheads which have proved a failure and which moreover only last a few years.

[11] See transactions, American Society of Civil Engineers, Vol. 23 and Report of State Geologist of New Jersey, 1905 and 1913.

Springfield Water-Works—II

SYNOPSIS—Description of some noteworthy features of construction work and some unusual developments in routine maintenance work. Supplement to Part I on the organization, plant and equipment, in "Engineering News," Aug. 26, 1915.

All water mains in Springfield, Mass., are laid by municipal day labor under the general supervision of the assistant superintendent of the water-works. Two gangs are constantly employed during the working season, each in charge of a foreman, and he and one or two of the more experienced laborers are the only permanent employees in this branch of the service. All service connections are

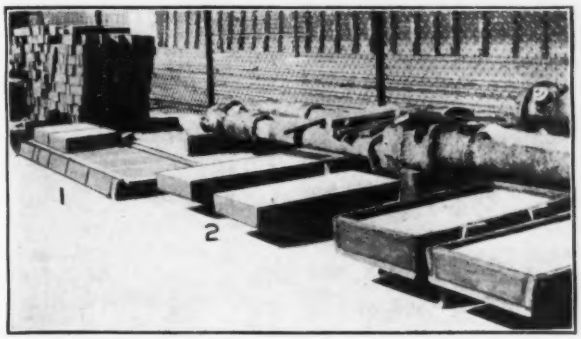


FIG. 1. CONCRETE BLOCKS FOR HYDRANT SETTINGS

made by a separate gang. For service pipe the city uses galvanized wrought-iron and lead-lined wrought-iron pipe. In the past, cement-lined pipe has been used for both mains and services. The pressures are high (87 to 147 lb.). Lead and leadite are employed for calking joints.

There are two or three details in connection with the construction work in setting hydrants which are of particular interest. Owing to the high pressures at hydrant connections, trouble was experienced with leaks caused by the lead-packed joints coming loose, due to the hydrant pushing out or settling in soft ground. To prevent this, a flat concrete block (about 12x18x6 in.) is placed under the base of each hydrant, at its junction with the main, and back of this connection a heavy double wedge-shaped block (about 24x12x6x4 in.) is inserted, which effectually prevents loosening of connections. These blocks (Fig. 1) are made in collapsible molds at the water-works plant on rainy days and in the winter time.

Another specialty is a gate-box of the water-works superintendent's (A. E. Martin) own design (Figs. 2 and 3). It was found that small changes in street grades were a constant source of annoyance to the water department, which is called on to reset the gate-boxes to the new grade. A telescopic box was designed, the lower part of which is of the standard type, but the upper half has a spiral flange or deep thread cast upon the exterior, and has slots to fit the prongs of a special wrench in the flange which holds the cover. Hence, to adjust the box to an new street grade it is only necessary to remove the cover, insert the special wrench (Fig. 3) and screw the box casting up or down, as the case may require. This casting is made in a local foundry and is not patented.

Records of all main gate valves, hydrants and services of 3 in. or over are kept in flexible-covered notebooks 8¼x11¼ in. in size. Fig. 4 is a reproduction of a part of a page. Each page covers a numbered section of the city, 1500x2000 ft., on a scale of 1 in. = 250 ft., and at least one valve without the border of the section on all

FIG. 2. SPECIAL GATE-VALVE BOXES

main entering or leaving this section is shown. Only three or four copies of this notebook are kept, one of which of course is part of the emergency-truck equipment.

Each valve is numbered, as shown, within a circle. Those numbers inclosed in squares or rectangles are sewer flush gates, which are two 2½-in. wheel valves (without the wheel) in ordinary valve boxes. A description of each gate location arranged consecutively by numbers is bound in a separate cover. These are printed in two rows to a page in large type and read as follows:

389

Winchester St., at Monroe, 4′ M.

22′ 8″ from N. E. corner, 33′ 6″ from N. W. corner of Monroe and Winchester Sts., 11′ 10″ S. of N. line of Monroe St. Spiral.

To find all the valves on a certain street or to locate a particular valve on the map, a printed index is provided, which is also bound into the notebook. The following is typical of the entries:

INDEX.

LOCATION	Main or Side	Numb
CHESTNUT ST.		
Worcester St.,	C	188

Wherever there is a chance of valves being added, blanks are left under each street heading to be filled in as may be necessary. Each foreman has a book of valve locations which is carried about in a canvas bag. When permanent objects to use as ties are lacking—as in the outlying, sparsely settled parts of the city—a concrete slab 8x1½ ft. by 4 in., not unlike a grave-stone in appearance, is set up beside the road and ties made to this. Fig. 5 shows such a slab. The letters W. G. (water gate) and the distance out to the valve in feet are cast on the face of the slab.

FIG. 3. SPECIAL WRENCH FOR CHANGING VALVE-BOX ELEVATION

Every service connection is located and the records kept on cards 4x6 in., of which Fig. 6 is a small-size reproduction. The cards are filed under the name of the street and the number on the street. The rough sketch on the reverse side (Fig. 7) is made in the field with a small field drawing kit consisting of a board about 10x14 in. with straight-edge and triangles attached and is the original record from which the typewritten description on the face of the card is made. These little surveys of the service connections were made at odd times by the superintendent's assistant until the records were brought up to date. Now it is a very simple matter to make the record when the service is installed. The record cards can be taken out of the files and to the job when it is necessary for any particular reason to find and dig out a service connection. During the winter there are the usual regular inspections of hydrants to prevent their being found frozen and useless in case of a fire. That this may not be considered merely perfunctory, and to have proof of careful inspection in case of complaint by the fire department, a system of recording these inspections has been devised.

FIG. 5. CONCRETE TIE SLAB

Every hydrant has a number tag, and the numbers of the hydrants inspected are recorded on a special slip, which each day is turned over by the inspector to the foreman in charge of this work. The slip contains space for any remarks, such, for instance, as: "Worcester and Fish Ave., number tag gone. No. 98—1 ft. of water; No. 419—3 ft. 6 in. of water."

The inspection slips are signed by the foreman and filed at the office, where a permanent record of all inspections is kept. These records are on blue-ruled cross-section paper, 15½x19½ in., which in vertical columns, gives the number of the hydrant, a description of its location, and a blank square for every day, each sheet sufficing for two months. A check mark in the square under the date of inspection signifies that the hydrant is in good condition, *F* means it is frozen, *W* full of water, 2 that there was 2 ft. of water in the hydrant, etc. Every hydrant is thus accounted for at least twice a week, and in severe weather every day or two.

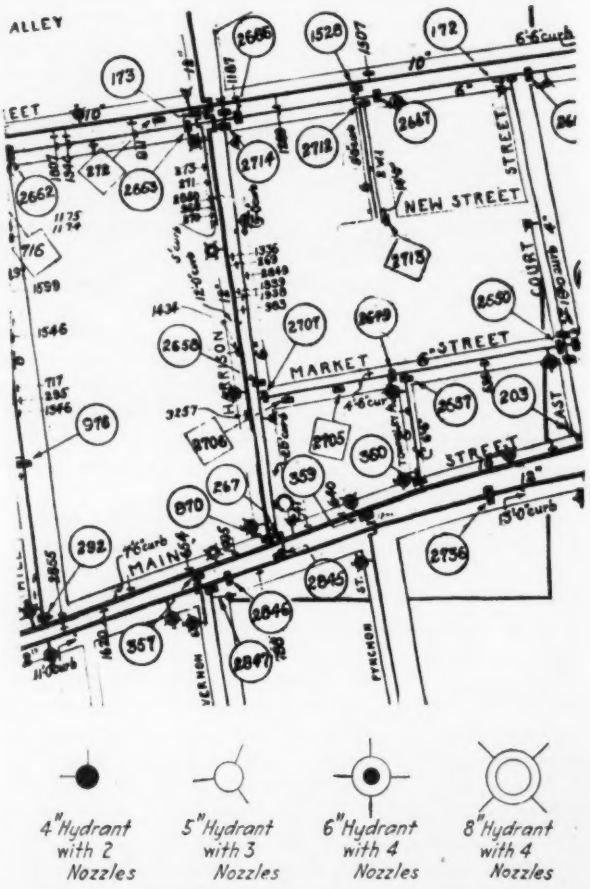


FIG. 4. PORTION OF GATE-VALVE RECORD MAP

An unusual feature of the water-works maintenance work is the regular employment of a water-gate testing gang. This is another of Mr. Martin's innovations. It was found that the gate-boxes frequently became clogged up, or the gates so set that to open and close them in an emergency was sometimes difficult, so a regular gang was organized whose sole duty it is to travel about the city

opening and closing, oiling and packing gate valves, and where necessary, in new street work, changing the elevations of the gate-boxes.

The gang is composed of a foreman and three men and is outfitted with a one-horse wagon (Fig. 8) and an equipment of picks, shovels, spoons, etc., for cleaning gate-boxes, wrenches and other small tools, not the least important of which is a small mirror for reflecting the rays of the sun into the gate-box. From 1200 to 1500 gates are tried each month, or every gate is tested at least twice a year. It is expected eventually to have a specially designed small motor truck for this service. This gang inspects hydrants during the four winter months.

No. 94 Shattuck Street
Owner F. W. & R. Zilinski S.R. 22047

Date	Work Done
5/22/15	Service pipe laid by Patrick Casey

Stop in walk I.K. (1") 9'0" from N line of St., 14'0" W of E line of body of house . Corp 15'0" from S line of St., 25'6" from stop in walk, online with same.

WATER DEPT., SPRINGFIELD, MASS. STOP LOCATION

FIG. 6. RECORD CARD FOR SERVICE CONNECTION

The foreman turns into the office each day a slip (Fig. 9) which gives the number of the gate valves inspected, the number of half-turns to open or close, the kind of cover, and any additional remarks, such as errors in recorded location, etc. A permanent record of these inspections is kept in the office on cards 5x8 in., of which Fig. 10 is a small-size reproduction. There is a card for each gate and a full record is kept on this card of every time the gate is inspected. The foreman in noting the

FIG. 8. GATE-VALVE TESTING GANG, SPRINGFIELD, MASS., WATER-WORKS

number of half-turns to operate the valve makes it possible for the office to check the completeness of his inspection, as well as to determine whether the gate is properly operating.

There are a number of advantages in such a regular gate inspection. It not only keeps the valve boxes free of dirt and in working order, but it familiarizes the men with the location and operation of all these valves, which is very important in cases of bad breaks. The gate valves are obviously an important part of a water-works system, and to have an efficient system every part of it should be kept in good working order.

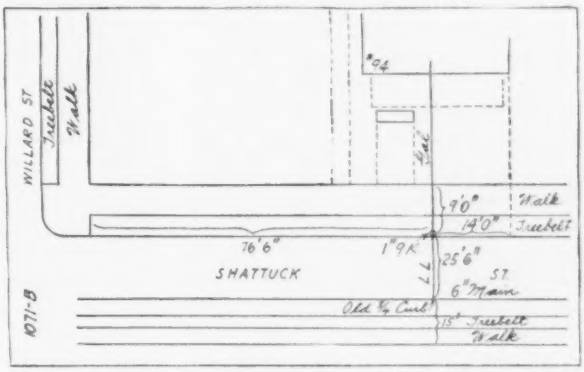


FIG. 7. REVERSE OF RECORD CARD FOR SERVICES

CITY OF SPRINGFIELD
WATER DEPARTMENT
FOREMAN'S RETURN
GATE INSPECTION
April 12 1915

GATE NO.	NO. OF HALF TURNS	KIND OF COVER	REMARKS
	Hayden St.		
988	41	Spiral	
1421	19	"	14'9" from E. lines of st.
984	36	R. D. W.	

FIG. 9. FOREMAN'S GATE-INSPECTION RETURN

WATER GATE
SPRINGFIELD MASS. No. 3358

DATE SET Sept 13/1912 LOCATION Albany St at 30" Circuit Main SHEET NO. 37
SIZE 8" MAKE Smith KIND PURPOSE Street Main OPENS Right
FULL TURNS TO OPEN 26 NORMAL CONDITION Open COVER Spiral

INSPECTION RECORDS

DATE	CONDITION FOUND	CONDITION LEFT	REMARKS	FOREMAN
6-22-11	Open	Open		Shubley
5-25-12	"	"		"
11-9-12	"	"		"
6-16-13	"	Open 1/4 turn	Cast Iron caused by Steam Opr.	Miller
7-29-13	Part Open	Open		Shubley
8-26-13	Open	Half open	For fear of settlement of main touch	"
9-6-14	Half open	Open		"

FIG. 10. INSPECTION RECORD OF GATE VALVES

Mr. Martin, in his annual report to the Board of Water Commissioners for the year 1914, when this part of the work was inaugurated, states: "This work (regularly operating the gates and keeping the boxes raised to grade) I consider of vital importance, as in the case of a break, minutes lost looking for a gate box are very valuable, to the extent sometimes of hundreds or even thousands of dollars." In making this statement he writes from many years' experience with such breaks; a serious one occurred just before the inauguration of the gate-inspection work noted in this article.

Rebuilding Rural Roads in the Southern States

By G. B. Buchanan*

SYNOPSIS—The peculiarities of Southern rural-road improvement are explained in the light of ante-bellum conditions. Methods and costs of reconstructing corduroy roads are given.

There are in the Southern States many miles of rural roads which are never seen by cross-country tourists and therefore are seldom considered in the widespread good-roads propaganda. Nevertheless they are important thoroughfares to the communities they serve, and their improvement is becoming urgent. While not calling for much engineering design, the improvement of these roads might very properly come within the practice of local surveyors and engineers, and the improvement may be extravagant or economical, according to the judgment and experience of the engineer.

Early Road Conditions in the South

A brief résumé of early conditions is essential to an understanding of some peculiarities now met with in Southern road work. It is well known that previous to the Civil War the South was preëminently an agricultural region of large estates and few railroads. Transportation to the market from the interior for distances of 100 to 200 mi. was by freight wagons; passenger travel was by stage, carriage and quite largely by horseback.

FIG. 1. SURVIVAL OF ANTE-BELLUM TRANSPORTATION METHODS; MOVING A 4½-TON BOILER FOR A SAWMILL

FIG. 2. EXAMPLE OF SOUTHERN CORDUROY ROAD BUILT IN CUT THROUGH BOTTOM LAND

Road laws were perhaps the most negligible of any of the laws. While the Southern highway commissions are now gradually developing efficiency in rural-road work, they are often hindered by the old-time county-supervisor system. With competent business men in office this system works well, but there are still too few uptodate men connected with these county-supervisor boards.

Before the Civil War the rural South had very few really public roads. The passenger or stage roads were mostly toll roads, built and maintained by individuals and not communities. The greater part of the freight tonnage was carried on other roads built and maintained over private lands by the owners of estates. This system had disadvantages. It was a handy vengeance to close the freight roads over one's estate to the wagons of an enemy. As these estates seldom contained less than 1000 acres and often many thousands, the closing of roads compelled a roundabout way to the market. There was also the possibility that cliques could "freeze out" other proprietors by combining to close avenues for freight hauling.

Haphazard Manner of Road Location

For years following the Civil War the old private-road system held sway, strangling many fine farms. Together with the scarcity of intelligent farm labor, it was one of the factors in the temporary stagnation of much Southern farming after the war. Even the incompetent labor left could have accomplished something had there been outlets for crops, which were not liable to be closed over night. Thousands of acres of once fertile lands were abandoned. Since then these large estates have been cut up into farms which one family can handle—from 25 to 300 acres—with some sort of highway guaranteed.

In many Southern road districts it has become an established legal principle that "roads existing when the estate was subdivided shall be roads for the different parts." At the same time such of the old freight and passenger roads as were desired were brought under the wing of the county-road organizations. This was the inception of practically the South's whole rural-road system, so it can be seen that in dealing with these roads we are dealing with highways largely planned and executed in accordance with private ideas or even temperamental whims. Records are meager, but those available show that the best roads were built by estate owners of military experience.

Corduroy Roads Become Unendurable

Years ago plank roads built as toll roads were much in vogue. Evidences of planking frequently appear on old Southern passenger roads, but for freight traffic sawed lumber was considered extravagant. Plenty of suitable poles, however, were generally handy to the wet places of these roads and there was likewise plenty of labor, so

*Surveyor, Woodford, Va.

corduroy roads were laid on soggy stretches. This habit persisted until very recently, when the popularizing of the automobile made corduroy roads no longer endurable.

The corduroy surfaces were rough, but of more importance, they had been laid largely in creek and river bottoms subject to overflow. In building a corduroy road a level surface was essential for the length of the pole; and labor being plentiful and earth-moving equipment scarce, the ante-bellum road builder obtained this level surface by digging and not by filling, as would be done now. We thus have roads through bottom lands as low or lower than the surrounding surface.

So heavy is the rainfall in the South and Southeast that high floods are customary, and while often a long-legged steer or horse could get over the submerged roads, modern low-hung automobiles cannot. Flood levels of 6 to 8 ft. or more are often found on these old corduroy roads making them quite impassable.

Reconstructing the Old Roads

The predominating kinds of timber dug out of the later-built roads are ash, sweet gum and pine. Much cedar, locust, sassafras, oak, etc., was used previous to the war. Long-lasting woods, like cedar, sassafras, white oak and locust, are still good, and if it were known that these woods only had been used, the improvement could be made on top of the old road. Other woods have decayed, or are decaying, and therefore the removal of the corduroy road must be considered in rebuilding these highways.

Five methods of rebuilding are practicable: (1) Machine excavation; (2) hand excavation; (3) burning; (4) filling over the corduroy; (5) relocating the road.

Plan 5 is much used. In the first place there was no inclusive scheme used in laying out these roads—there may be several roads in the course of a few miles and there may be 5 mi. between the next two. Grades are either steep, or the road over the elevation is unnecessarily roundabout. As the surface of roads should be high enough to provide drainage, it is usually found more costly to fill the excavation made for a corduroy road than to grade a new roadbed.

Where cleared land is available for a new location and condemnation proceedings are not forced, a relocation is the most economical solution of the problem. Nevertheless this cannot always be done. Again, the corduroy roads have been mostly in river-bottom lands, where timber or heavy brush is generally found, so that any estimate for a relocation must consider the cost of clearing a new right-of-way.

Plan 4 is used where relocation is undesirable and where the finished surface of the roadway is to be 30 in. or more above the buried wood. In this case, for the gravel road now largely being built throughout rural Virginia, at least 18 in. of soil from near-by borrow pits is filled in over the old road, then 12 in. of bank-run gravel is spread for surfacing material. The cushion of soil is usually compacted by rolling in about 18-in. layers. The gravel is not compacted except by the teams and wagons hauling it.

Control of the Traffic Loads

Thus cheaply built and well-maintained, this type of soil-gravel road has been found suited to moderate automobile traffic, and it will hold its surface if heavy loads are prohibited while the surface and soil cushion are soggy from thawing or long wet periods. In the South roads are subjected to continuous freezing and thawing all through the winter, which is extremely trying to any type of earth road. Frequent rains are experienced also. By several state laws boards of supervisors are given authority to control loads on improved highways, and this authority is now largely exercised, the limit being 1000 lb. per wagon when the roads are thawing or soggy.

Perhaps 75 per cent. of the heavy traffic over Southern rural roads has heretofore been in lumber and allied industries, the little country sawmills sending their product to rail or water by two-, three- and four-mule wagons. Lately, some tractor hauling has been tried with fair results, although it is found that curves are of too short radius and grades too abrupt for much success at this time with the wagons used. No effort has been made to secure special trailers, and a long string of ordinary wagons is very unwieldy.

Cross-ties, excelsior, pulp and cordwood are produced whenever farm work is slack, as well as sawed timber. Regulations limiting loads are opposed by many at first. This quickly ceases, however, when it is seen that reducing the loads for the short periods required enables good loads to be hauled all through the winter, instead of diminishing the load as the winter proceeds because of the total demolition of the road surfaces.

Where a road cannot be relocated and filling over the old corduroy surface is impracticable, the poling can be removed in one of three ways. It depends on conditions which is the most economical. Burning is not extensively

FIG. 3. FLOOD PROTECTION BY WOVEN BRUSH
Screens of woven brush are fastened to the fence posts to prevent scour

FIG. 4. A 70-YEAR-OLD RURAL ROAD
Drainage ditches 12 ft. deep, overgrown with brush and dangerous

practiced and is confined to roads in clay soils generally classified as gumbo. A fire dries out this material so it can be compacted without gumming up the road-roller wheels. This kind of clay must be well compacted, for otherwise the gravel will work down into it and in rainy weather ruts will cut clear through the gravel. However, the burning of the poling is only a part of the fire applied, much brush being burned also.

To burn the poling the earth covering is first dragged off with a road scraper with the blade set horizontally. The poles are then allowed to dry out, when some handy inflammable fluid is applied. This will cover the poles most effectively if sprayed on in a moderately heavy spray. The fire should be set to burn against the wind, as otherwise it will sweep over the poles without generating its full heat.

No cost data are at hand to show the relative efficiency of machine and hand methods of uncovering the poling, but it is evident that with the ordinary road machine found in most Southern districts, hand digging is not any more expensive. The only machine usually available is the blade scraper, which has so low a clearance that the outfit must stop every few feet to clear out the material from under it. In hand digging the earth covering the poling is first scraped off, when a heavy subsoil plow may be run near each end of the poles, the point plowing down under the poles. This rips up the sound poles, which are then carried off to suitable piles. The rotten poles are broken up by this process and must be dug out by hand.

Sound poles of lasting wood, like cedar, locust, white oak and sassafras, can be dried out and worked into fence posts selling from 10 to 25c. each.

It would appear sound to estimate from $100 to $500 per mile for digging out old corduroy roads when bidding on Southern road work, where much poling is found and the specifications require its removal.

The Australian Transcontinental Ry. will be finished by the end of 1916, according to a recent report by the Chief Engineer, N. G. Bell. On the West Australian section the final locating survey has been made for a distance of 260 mi. and preliminary surveys as far as the South Australian boundary. The line has been completed ready for track laying for 240 mi. in West Australia and 264 mi. in South Australia.

New Trenching Machines

A special class of excavating machinery which has been developed very extensively is that for digging the deep and narrow trenches required for water mains, sewers and tile drainage. Two excavators, of different types, for this class of work, are shown in the accompanying illustrations. They are being introduced by the Pawling & Harnischfeger Co., Milwaukee, Wis.

Ladder Excavator

The machine shown in Fig. 1 has an endless chain fitted with buckets, the chain being carried by a boom or ladder frame which has its upper end pivoted to fixed frames on the deck of the machine. The ladder is a heavy box girder, which is held at the required position by tackle from the cantilever ends of the fixed frames. Its weight serves to hold the buckets against the breast of the cut, and the method of suspension enables it to swing up if the buckets strike a heavy boulder or other obstacle.

The buckets are of cast steel, with removable teeth of tool steel, and are attached to a chain composed of cast-steel links having a pitch of 10 in. The buckets can be changed readily to give the desired width of trench. Ordinarily the range of work is 12 ft. in depth and 27 to 39 in. in width; but an extension of the ladder provides for a depth of 15 ft., while buckets of greater width can be used if necessary. The contents of the buckets are dumped upon a transverse 24-in. belt conveyor of suitable length, which can be extended on either side. A scraping device insures the complete discharge and cleaning of each bucket.

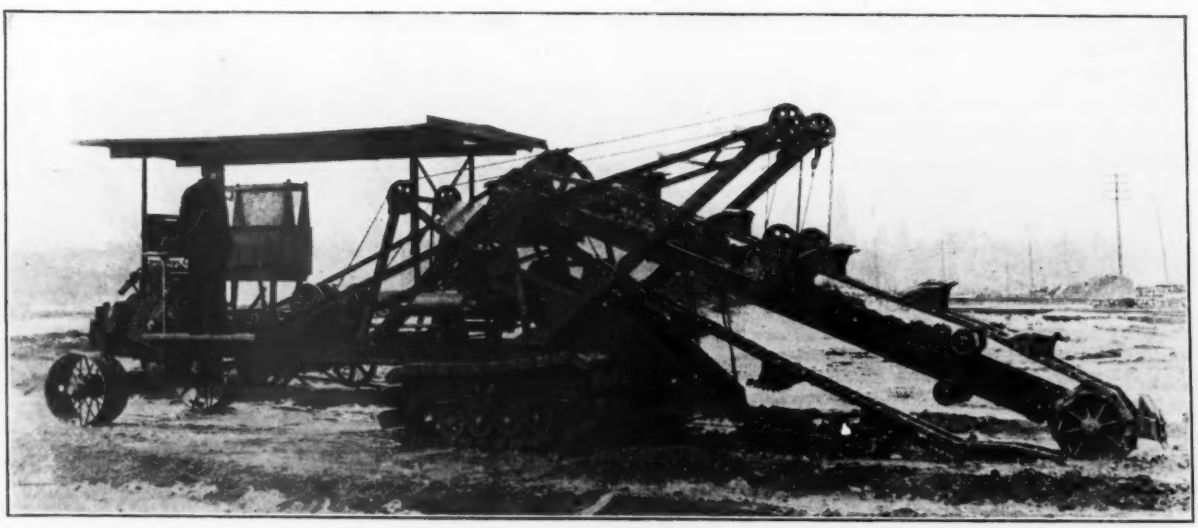


FIG. 1. TRENCH EXCAVATOR OF THE LADDER TYPE FOR SEWERS, WATER MAINS, ETC.

The machine has a steel frame 22 ft. long, to which are attached the cantilever frames carrying the end bearings and the hoisting sheaves of the ladder. It has a pair of 34-in.-wide tired wheels at the front, while at the rear are a pair of caterpillars 7 ft. long and 30 in. wide. These caterpillars have their frames pivoted on a heavy cross-shaft, so that they can accommodate themselves independently to the inequalities of the ground. They are driven by sprocket chains. A bevel-gear differential equalizes the strains when turning curves, and brakes on the chain sprockets provide independent control of the caterpillars to assist in making very short turns.

Power is furnished by a 70-hp. four-cylinder vertical engine, which can work on gasoline, kerosene or motor spirit. This is geared to a countershaft, from which the upper tumbler of the ladder chain is driven by a steel roller chain. The caterpillars, the feed gear and the ladder hoist are all driven from this shaft by means of chains. The feed is through a gear train which gives six rates of speed, ranging from 1¼ ft. to 5 ft. per min. The ladder hoist is operated through bevel gears and a worm gear. The steering is effected by a hand-operated gear driving a shaft having drums, from which chains are led to the front axle.

The operating levers are so grouped that all movements can be controlled by one operator. The machine is 52 ft. long over all, and weighs about 22 tons in working order. It has been used on sewer trenching work in Chicago.

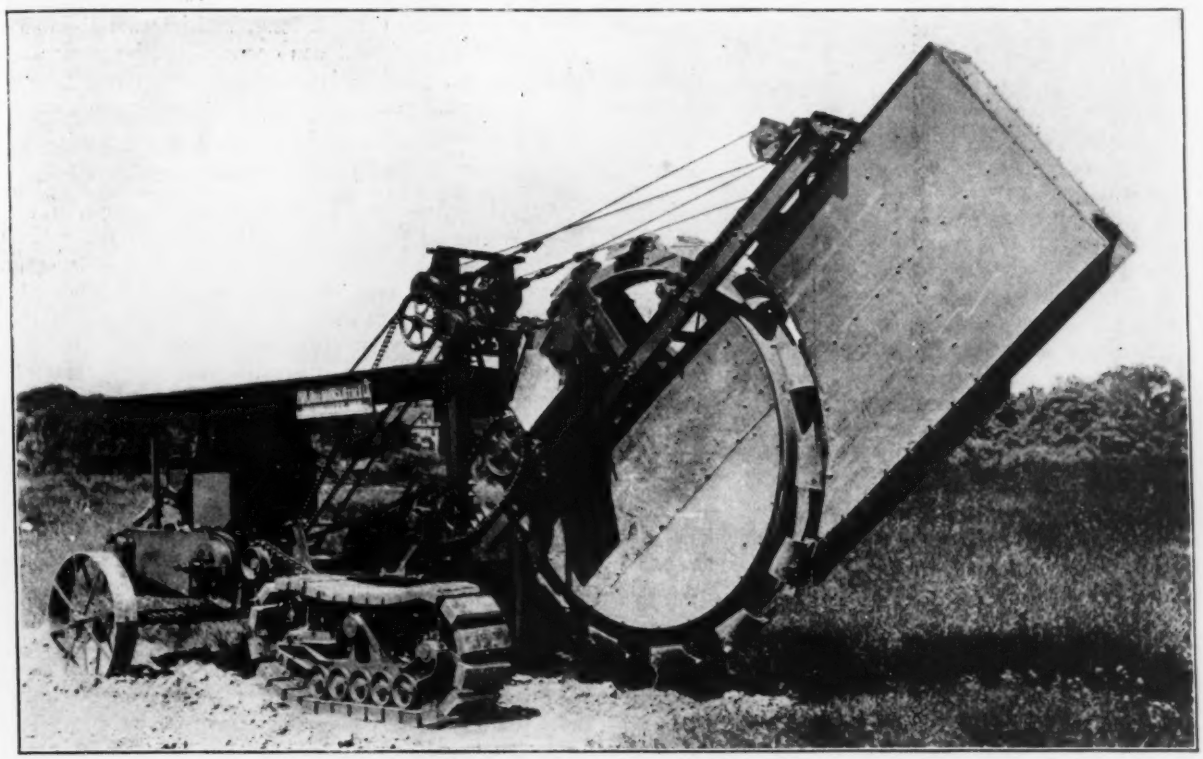


FIG. 2. TRENCH EXCAVATOR OF THE WHEEL TYPE, USED MAINLY FOR TILE-DRAINAGE WORK

Wheel Excavator

This type of machine is used mainly in tile ditching or drainage work, but is also employed for pipe lines, etc. The wheel which carries the excavating buckets has no axle, but the inner face of the rim rides on friction rollers carried by a frame within the wheel. A pinion driven by a sprocket chain engages an internal gear on the rim. The wheel is inclosed by a steel housing as shown in Fig. 2 which serves to support the sides of the trench.

The box in the rear of the wheel is for the protection of the tile-layer, preventing the trench from caving in upon him. The bottom of the box forms a shoe to smooth the bottom of the trench and give it a concave form to receive the tile. The buckets are cleaned by a stationary spade or scraper, and knives or rooters can be added for work in hard material. The excavated material is delivered on either side of the trench by a steel chute when the spoil is to be delivered close by or by transverse conveyors composed of steel slats when it is to be carried some distance.

The main frame of the machine is supported by a pair of wheels on the steering axle and a pair of caterpillars at the rear. Upon it is a gallows frame carrying two pairs of drums. The upper drums are for the topping-lift cables which lead to the outer end of the boom carrying the wheel. The lower drums are for cables which are attached to a crosshead on the inner end of the boom, raising and lowering it in the vertical frame.

These machines excavate trenches up to 7½ ft. deep and 12 to 24 in. wide. Power is furnished by an internal-combustion engine of 20 to 45 hp., and the rate of feed varies from 1¾ to 7½ ft. per min. in machines of different sizes.

The accompanying table gives the record of work done by a wheel machine of the type shown on this page, used by C. D. & J. T. Pierson, of Terre Haute, Ind., for drainage ditching in gumbo soil.

PERFORMANCE OF A WHEEL EXCAVATOR ON TRENCH WORK FOR TILE DRAINAGE

Record	A	B	C	D	E	F
Hours worked	10¾	11	11	11	11	12
Hours delay (incl. noon)*	3	3	2	2	3	2
Net working hours	7¾	8	9	9	8	10
Gasoline, gals. (at 11¼c.)	12	13	15	15	13	20
Cost of fuel and lub. oil	$1.68	$1.85	$2.17	$2.17	$1.85	$2.90
Number of men	3	3	3	3	3	4
Labor cost per day	$6.50	$6.50	$6.50	$6.50	$6.50	$8.00
Total cost per day	$8.18	$8.35	$8.67	$8.67	$8.35	$10.90
Trench (11½ in.), depth	42 in.	42 in.	42 in.	44 in.	42 in.	36 in.
Trench, length, ft.	1650	1952	2887	2310	2838	5032
Cost per lin.ft.	0.50c.	0.43c.	0.30c.	0.37c.	0.29c.	0.21c.
Cost per cu.yd.	3.98c.	3.45c.	2.41c.	2.89c.	2.37c.	2.04c.

* Delay includes 30 min. or 1 hr. at noon, and is mainly the time required to move the machine from one trench to another.

The accompanying table gives the record of work done by a wheel machine of the type shown on this page, used by C. D. & J. T. Pierson, of Terre Haute, Ind., for drainage ditching in gumbo soil.

Difficulties Overcome in Sinking a Deep Well

By P. E. Green*

SYNOPSIS—In sinking a well about 1550 ft. deep at Oglesby, Ill., various difficulties such as cave-ins, lost tools, plant breakdowns and mine flooding were met and overcome by the contractor and the engineer.

Oglesby, Ill., situated in the Illinois River Valley near the junction of the Illinois and Vermilion Rivers, has recently completed a deep well for water-supply purposes. Some of the difficulties encountered during the work seem to be worth recording.

In the immediate vicinity of Oglesby the strata are very badly folded and broken up, but in the main there are about 20 ft. of overlying soil, about 500 ft. of various kinds of shales, all having a tendency to cave and disintegrate when exposed, about 300 ft. of dolomite and limestone with occasional layers of shales, and from that point to the St. Peter sandstone which was encountered about 1550 ft. below the surface, the rock is generally a variation of close-grained limestone, being solid and fine grained from 900 ft. on.

The city is situated over coal mines, the first at 225 ft. and the second about 500 ft. below the surface. These mines are absolutely dry mines, and hence there has been no provision made for drainage. These facts were brought to the attention of bidders for the well. In a well drilled about one mile distant, salt water had been encountered some 585 ft. below the surface and had developed a head of approximately 400 ft. The attention of bidders was called to this fact, also, but the successful bidder failed to make adequate provision for taking care of the salt water.

The well-drilling plant consisted of a large timber tower for handling the well casing, drills, etc., a steam boiler and a single-cylinder noncondensing steam engine driving through a belt about 35 ft. in length a 10-ft. diameter wheel. This wheel, operating through a friction clutch and wire rope over the tower, handled the casing, tools, bailers, etc. The wheel also directly operated a large timber walking beam by means of which the drills were churned up and down. The tower was made of sufficient height to handle two 20-ft. lengths of pipe casing at one time.

Work was actually started Feb. 23, 1915. The first 20 ft. to bedrock, through loam and clay, etc., was cased with 18-in. internal diameter steel drive-pipe. No water was encountered. Then for 330 ft. the hole was cased with 14-in. internal diameter wrought-iron pipe, of the heavy screw-drive coupling type. The hole was dry all the way. At this depth, the 14-in. casing was set on a good shoulder and drilling proceeded with a 12-in. hole, which was cased with 10-in. wrought-iron drive pipe.

The casing passed through two coal mines, parts of which have been worked out and abandoned. In the second coal mine the 10-in. pipe passed through an old entry, from which the track had not been removed, though the entry (in solid rock) had been filled with débris from the active part of the mine. This casing ended 600 ft. below the surface, where it was set on a shoulder and sealed to the 14-in. casing with a lead packer. The hole continued dry to a point 815 ft. below the surface, where a small vein of salt water was encountered amounting to about 320 gal. per hr. At 875 ft. a heavy flow of salt water was struck, amounting to 2400 gal. per hr. This water was kept down with a bailer (an 8-in. cylindrical tube or pipe, about 25 ft. long, with movable bottom) which held 60 gal., and was operated by the tower and steam engine. The bailer, working at the rate of one trip per minute, could lower the water and permit intermittent drilling.

Cave-In of Uncased Well

At this time occurred a cave-in of the uncased well, the 10-in. casing on its shoulder being about 200 ft. above the bottom of the well. This cave-in was of such a character that the tools had to be abandoned temporarily and the rope was cut about 20 ft. above the top of the drill. A few hours later the boiler broke down, because of bad water. Here is where the real trouble started. The salt water now rose around the outside of the 10-in. casing and into the abandoned entry of the second mine, which was about 550 ft. below the surface of the ground and 330 ft. above the bottom of the hole. Ordinarily the weight of casing on its rock shoulder would shut off any water and prevent it from rising outside the casing, but the 10-in. casing had been sealed to the 14-in. with a lead packer to keep the salt water out of the well itself. Hence the 10-in. casing did not bear its full weight on the stone shoulder, but on the packer, and while it kept the salt water out of the well, it did not prevent its entering the mine. This mine had been worked for 40 years and was an absolutely dry mine; there was no provision for drainage and the entrance of 40 gal. of water per min. became a serious matter.

A Mine Flooded

As soon as it was seen there might be trouble with the salt water, men were set to work by the mining company clearing out the abandoned entry, the distance to be cleared amounting to about 600 ft. Since the entry was low, only a few men could work at one time, and it took one week of work of two shifts of three men each to get to the well. The temperature in the entry was about 90 deg. F. and the ventilation poor. About the time the entry was cleared and the well casing exposed, the contractor's surface-boiler broke down, as stated, and several tubes had to be replaced. In addition the friction clutch, because of constant operation with the bailer, gave way and had to be repaired. The water at once rose rapidly into the mine and caused a great deal of apprehension, since thousands of dollars worth of property would be damaged by flooding and several hundred men thrown out of work. It took several days to get new tubes for the boiler.

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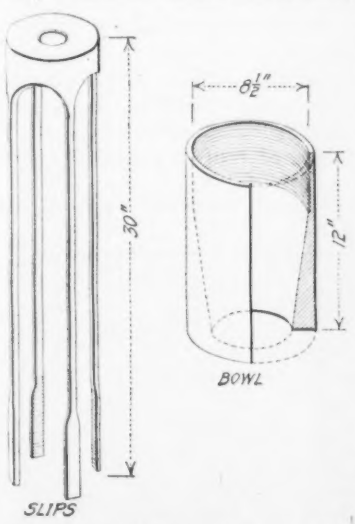
The tools were lost on Apr. 4. The boiler and bailer had been worked continuously until Apr. 8, when the boiler broke down as related. The contractor had no other pump, the new boiler tubes ordered had not arrived, and in this emergency the engineer took charge and ordered a 5-in. deep-well pump, 600 ft. of drop pipe and a steam head, shipped by express from Chicago. They were ordered the night of Apr. 10 and arrived in Oglesby the next afternoon. The same morning, the boiler tubes arrived, were installed, and bailing was resumed.

Sealing the Mine Entry

The plant had been out of commission for three days, during which time several hundred feet of the mine had been completely flooded. Fortunately, for the entire distance of 600 ft., the mine sloped toward the well. During the morning of Apr. 11 the bailer started to lower this water and by the afternoon of Apr. 13 the water had been lowered so that the work of sealing the entry around the well casing could proceed. The heat in the entry was intense, only two men could work to advantage at a time and all material had to be brought from the surface down the shaft and through the main entry, a distance of one mile. When the well casing was finally exposed it was found that the drill in coming through the mine had threshed around considerably and that a cone-shaped hole extended for about 20 ft. below the floor of the mine entry. This hole was about 24 in. in diameter at the top, decreasing to about 14 in. at the bottom. It was carefully cleaned out, the walls washed and scrubbed and then filled with rich cement mortar. The well casing exposed in the mine was then cased in a column of reinforced concrete 6 ft. sq. quite to the roof of the mine. In less than 24 hr. after this was completed the bailer on the surface broke down, but the cement had set sufficiently so that the water was entirely shut off. After the bailer broke, the salt water continued to rise inside the well reaching a height of 785 ft. from the bottom, which was within about 100 ft. of the surface of the ground, the total head of salt water varying from 715 to 770 ft. From 815 to 840 ft. the material encountered was a good hard limestone, yet the first salt water flow was from this material. From 840 to 850 ft. the material was a slate. From 850 to 875 ft. were layers of limestone, clay and slate mixed and at 875 ft. the sand vein, from which the heavy flow of salt water came, was encountered.



BOWL AND SLIPS FOR RECOVERING WELL TOOLS

After the mine had been sealed off, operations were started for the recovery of the tools. When the tools were lost the contractor had ordered about 1000 ft. of 8-in. oil-well casing, the intention being to force this casing down through the cave-in and over the tools and then get hold of the tools with a grab tong or bowl and slip. The casing was ordered about Apr. 5 but did not arrive until Apr. 23 having been lost in the railway yards at Chicago in the meantime. From Apr. 14 to 23 the water stood at full depth in the well. Since the lower 200 ft. of the well was uncased at the time, the water caused the material to soften and disintegrate and much more of the well caved in, there being finally about 200 ft. of débris on top of the lost tools. This made their recovery very difficult. It had been the intention to drop the 8-in. pipe down over the tools, as it was thought that the first cave-in was simply a bridge, and that the 8-in. pipe could easily be driven through it. This was found impossible on account of the fact mentioned before that the well had further caved in for a distance of 200 ft.

Bowl and Bowl Slips

The débris was then drilled through in much the same manner as the original well, and when it was thought the drill was within 10 or 15 ft. of the tools a casing bowl was put on the lower part of the 8-in. pipe with the intention of forcing this over the tools. This bowl (see accompanying sketch) is a piece of pipe having one end threaded to screw over the 8-in. pipe, while in the other end the interior is cone shaped, with the small diameter at the bottom. The plan of operation was to force it down around the tools, then lower the grab tongs or bowl slips, as they are called, over the tools. The bowl slips (see sketch) consist of four spring steel prongs about 30 in. long, with the lower ends of the prongs flattened out to form a sort of paw, the four prongs constituting a cylinder. The inside of the paw end of the prongs has cut threads like a pipe wrench. Since these prongs are long they have a very considerable spring to them and hence the bowl attached to the pipe when pulled up tends to force the paws tight into the tools. The entire length of 800 ft. of casing is then pulled and the slips, contracted by the cone of the bowl, tightly clasp the head of the tools.

The first attempt failed, because the bowl could not be forced over the tools, for the reason that the original 20 ft. of rope which had been cut off when the tools were abandoned was found to have been churned into such a mass that the pipe could not be forced through it. All the 8-in. casing had then to be pulled out, the bowl taken off, the pipe dropped down and drilling started again.

Much trouble was encountered before the bowl was finally forced over the ends of the tools. On Apr. 27, 28 and 29 the space surrounding the lost tools was drilled with a spud, thus enlarging the hole and cleaning out and exposing the tools farther down. It should be noted that all drilling for the recovery of the tools was through the 8-in. casing hung from the top of the well. On Friday, Apr. 30, a hold on the tools was finally obtained with the bowl and slips. It was found impossible to budge the tools, however, with a straight pull. A double block was then put on the derrick with a bull hitch and when this was pulled the 8-in. casing pulled apart at the top nipple. The nipple was probably poorly threaded. The pipe was rethreaded and a new nipple supplied and then the linked "elevator," or cross arm upon which the straight pull was applied, pulled apart. This was Friday, May 7. The entire week had been taken up with these two unsuccessful attempts. On Saturday, May 8, a 6¼-in. drill was installed and again the drilling around the tools started, and for six days continued, when the hole around

the tools was 40 ft. deep. The 8-in. casing and the bowl and slips were dropped down over them and this time the tools pulled up for 10 ft. to refusal. They were then driven down with drills, the bowl and slip dropped over them again and the tools finally recovered on May 17, a total of six weeks after losing them. The cost of fishing was $720 for labor, and $180 for other expenses, making a total of $900.

After the tools had been recovered the drilling proceeded without any difficulties, the 10-in. casing having been set on a shoulder at 600 ft. below the ground and sealed at its junction with the 14-in. casing with a lead seal in order to keep the salt water out of the well, and at a distance of 950 ft. below the surface of the ground the 8-in. pipe was set on a good solid rock shoulder and then sealed to the 10-in. casing making a continuous and tight pipe to the shoulder. The wall at this point was a very close grained, dense limestone and there was no reason for any further casing.

Straightening the Drill Hole

At 1200 ft. below the surface of the ground the drills, for some reason not exactly understood, began to get out of the perpendicular line. This was probably caused by a projection over which the drills slid; at any rate it was found that there was a deflection of several inches from the perpendicular in the drill hole. The drills were withdrawn and 50 ft. of boulders and small pieces of cast iron were dumped into the hole, tamped down and drilled through again, thus straightening the hole, and no further trouble was encountered. At 1275 ft. the great timber walking beam split and this caused a delay of four days while a new one was being made. The cost of this incident was $100.

The fine grained limestone in this section, that is, between El. 1000 and 1400 ft., was found to yield about 60 gal. per min. of clear water of excellent taste. The salt water had been effectually cut off by the weight of the 8-in. casing resting on the rock shoulder.

At a depth of 1400 ft. the cast-iron saddle of the walking beam broke twice in succession, causing a week's delay. At 1445 ft. the St. Peter sandstone was encountered. About here the bottom 6 ft. of the drill broke off. It was recovered with slips operating at the end of the drill cable. At 1548 ft. a clay formation was encountered and the well declared finished. It was tested for capacity, and 300 gal. per min. for 13 hr. was pumped without exposing the well cylinder, which was set 250 ft. below the surface of the ground.

The contract price of the well complete was $6628, delivered to the city. The cost to the contractor on account of lost tools, etc., was about $1100. The mine cost (concreting, cleaning entry, etc.) was $460. The cost to the city for use of the rush order pumping machinery was about $275. The contractor under the specifications must stand this entire expense, but the city did not force him to pay for the extra pumping equipment.

The contractor, H. H. Adkins, of Sullivan, Ind., worked hard and faithfully, and, though lacking somewhat in necessary equipment, handled his work very skillfully. The writer was consulting engineer for the city of Oglesby.

Reinforced-Concrete Flagpole at Panama

By G. C. Dobson*

A reinforced-concrete flagpole erected on Administration Hill at Balboa Heights, Canal Zone, presents a unique piece of construction. It stands on the principal axis of the Administration Building and 59 ft. in front of it. Its position at the head of a spacious flight of steps from the terrace to the main townsite gives it added prominence.

The pole has a clear height of 70 ft., a ground penetration of 12 ft. and rests on natural soil. It is sixteen-sided

*Assistant Engineer, Permanent Building Division, Panama Canal.

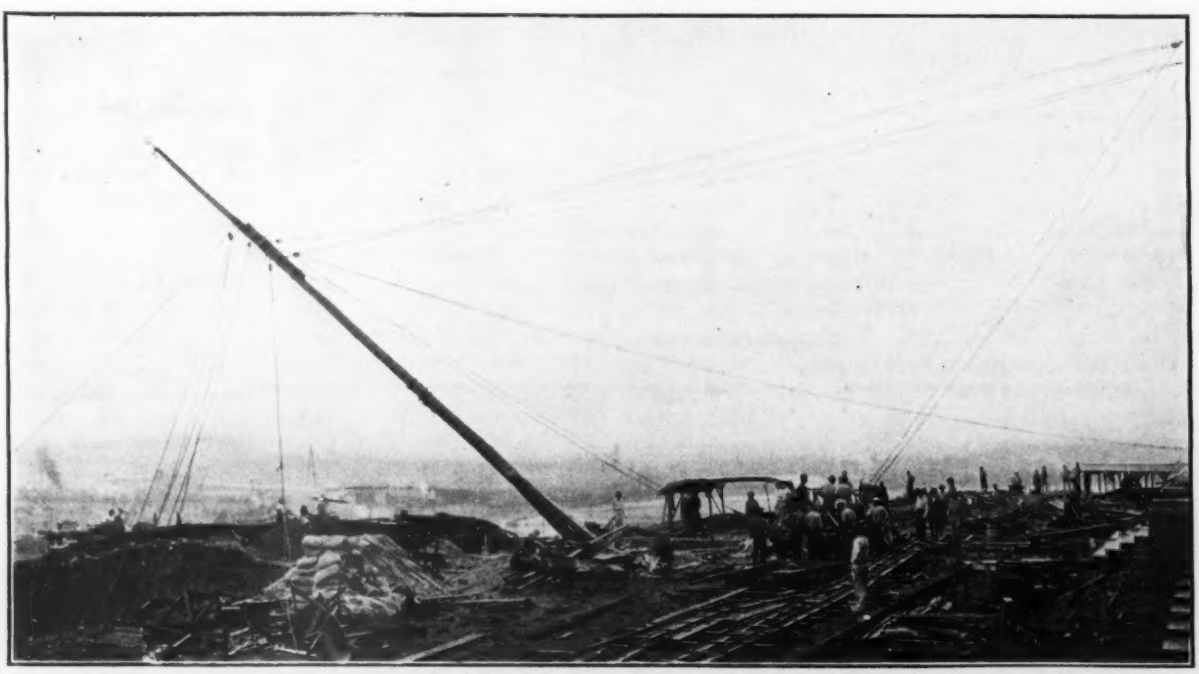


FIG. 1. RAISING THE REINFORCED-CONCRETE FLAGPOLE IN FRONT OF ADMINISTRATION BUILDING

and has a diameter of 8½ in. at the top and 17 in. where it joins the ornamental base. It is reinforced longitudinally by eight square bars, which are 1½ in. in thickness at the base, graduate down to ¾ in. at the top, and

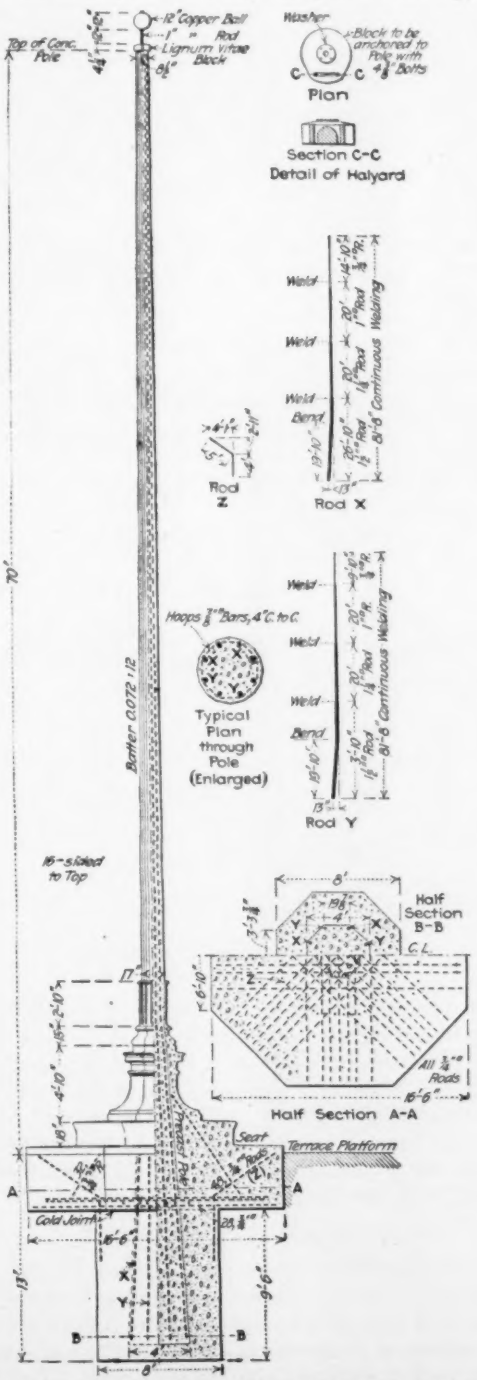


FIG. 2. DESIGN OF REINFORCED-CONCRETE FLAGPOLE AT PANAMA CANAL

are welded so as to form continuous bars. The welds are reinforced and staggered. The pole is also reinforced by hoops of ⅜-in. square bars spaced every 4 in.

The pole was precast in position for erection in wood forms, which had to be constantly adjusted to keep the pole in alignment, due to the settling of the fill on which the forms were set up and to blasting in the neighborhood. The concrete was a 1 : 1 : 2 mixture. Eighteen days after pouring it was erected. Stresses were developed during erection much greater than would be caused by a hurricane of 100 mi. per hr.

The lower 10 ft. of the pole consists of a spreading octagonal base of flutes and plain moldings, with a seat and platform at the bottom. These members were all precast and set up after the pole was erected. They are about 3 in. thick and heavily reinforced with mesh. The pole itself received a thin coat of stucco after erection to true up the arrises and to remove all form marks.

To the top of the pole is secured a very heavy cast-brass pulleyless block, through a groove in which slides the flag halyard, and through the center a 1-in. brass rod projects 1 ft., carrying a 12-in. copper ball, double gold leafed. The center of this ball is about 167 ft. above sea level. At the base the halyard passes through the cap molding and is secured to a cast-brass cleat directly below it.

The method of erection is shown very clearly in the accompanying photograph. Two electric winches were employed.

The pole was designed and erected by the Permanent Building Division, Supply Department, Panama Canal. The erection was done under the direct supervision of the Division Engineer, Frank Holmes. The architectural design was handled by S. M. Hitt, Architect of the Panama Canal, and the engineering design by the writer.

An Automatic Speed-Control and Train-Stop System has been given a trial on the Chicago, Burlington & Quincy R.R. The installation covers 6 mi. of single track, with several track contacts or block stations for movements in both directions. The special feature is the control of train speed by "Caution" indications and the application of the brakes by "Stop" indications. The contact rail is normally energized and causes a lamp to be lighted in the cab, indicating that the engine has entered the block section. The engineman presses a button, by which the lamp is extinguished and a record made of his action. In starting from a terminal, only a limited (and prescribed) speed can be attained, and a whistle in the cab sounds until the engine passes a contact point at "Clear," after which the engineman has full control of the speed. For a "Caution" indication, the contact rail is partly energized, and causes the train-control apparatus to reduce the speed to the prescribed limit. It also causes the cab whistle to sound continuously. If the indicator at the next contact point is "Clear," the train-control will be made inoperative, but if the indication is "Stop," the brakes will be applied and another whistle sounded. In order to proceed, the engineman must unlock and open a box and set the apparatus for the slow-speed condition. He cannot set it for full speed, this being done only automatically when the engine shoe strikes an energized contact rail. The opening and closing of the box and the setting of the apparatus are all registered, so that all the actions of the engineman are on record. This system has been installed by the Gollos Railway Signal Co., 76 W. Monroe St., Chicago. Hiram J. Slifer, Rookery Building, Chicago, is consulting engineer for the company.

Difference Between Investment and Value of a small public-utility property is illustrated by the recent appraisal case of the District of Columbia Public Utilities Commission in re Washington & Maryland Ry. Co. This company operates a short, struggling electric railway extending out from the outskirts of Washington. The amount expended in construction and equipment as shown by the records was $119,558, while the reproduction of cost was $67,047, and the reproduction cost less depreciation was $61,381. In determining cost of reproduction 5 per cent. was allowed for engineering and superintendence, 3 per cent. for interest during construction and 3 per cent. for the legal, organization and insurance items, omissions and contingencies. Many of the original investments were wasted expenditures. Some parts of the installation were abandoned after a short time; others were not in service for considerable periods and were not well maintained. Most of the plant now actually used and useful has recently been built or rebuilt.

Three-Mile Approach Viaduct, St. Louis Municipal Bridge

A total length of 16,300 ft. and a steel weight of about 23,000 tons characterize the viaduct[1] which forms the east approach of the St. Louis municipal bridge over the Mississippi. Its size makes it one of the most important pieces of viaduct construction in this country. About two-thirds of the length of the structure is railway viaduct and about one-third highway viaduct, the two being of different types.

Features of the design are: Simplicity of the general arrangement; extensive uniformity and duplication without sacrifice of economy; the use of the main girders as track stringers in the highway floor, saving both in stringers and in floor-beams; and provision for expansion in every intermediate span.

The footings of the viaduct columns are on piles. The concrete piers extend about 15 ft. above ground, to get above flood level.

General Arrangement

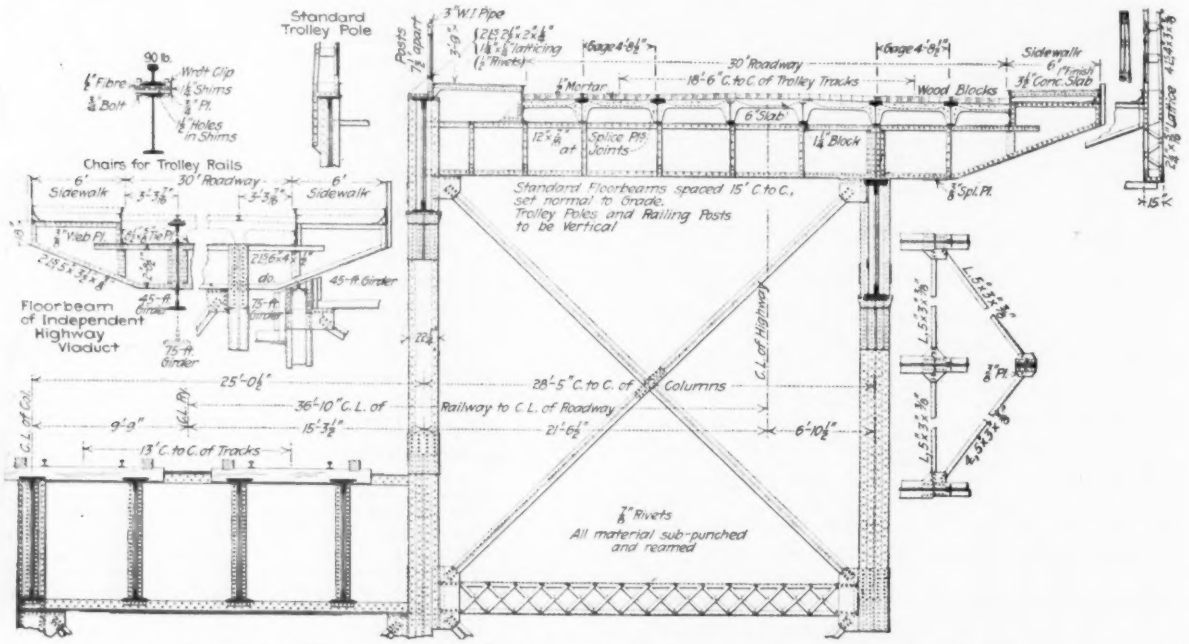
The approach passes almost directly eastward from the east end of the river bridge, crossing over all the railways in the east bottoms. The length of viaduct from the bridge to the east end of the approach is 13,300 ft. The first 2300 ft. is combined highway and railway viaduct, and at its end the highway viaduct diverges northeastward, extending 3000 ft. to Tenth and Pickett Ave., East St. Louis, while the railway viaduct continues east for 11,000 ft.

The design includes provision for two future turnout viaducts for railway connections—(1) a turnout to the northward, starting near the river bridge, for connection with the Pennsylvania R.R. tracks, and (2) a turnout to the south starting at the point where the main railway and highway viaducts diverge, for connection with the Illinois Central R.R. These are not being built at the present time.

The gradients of the approach are 2.015% on the highway structure and 0.128 to 0.983% on the railway structure.

The drawing herewith shows the combined portion. The separate railway viaduct in its arrangement of parts is identical with the railway half of the combined viaduct. The separate highway viaduct differs from the highway half of the combined structure in having its roadway centered over the columns and its longitudinal girders raised up so that the floor-beams connect to their webs.

The determining feature of the arrangement is the 15-ft. floor panel of the highway viaduct, which was maintained uniform throughout the structure (except for a few end panels of slightly different length). This panel-length permits of using rolled I-beams as stringers with considerable economy. The panel length determined the spans as multiples of 15 ft. The columns being braced in sets of four as towers, according to regular viaduct practice, the normal spans adopted are 45 ft. for the towers and 75 ft. for the intermediates.



CROSS-SECTION OF EAST APPROACH VIADUCT TO ST. LOUIS MUNICIPAL BRIDGE

[1]Contract for the steelwork was let to the American Bridge Co. July 9, 1915, as noted in "Engineering News," July 15.

Highway Viaduct

The street-railway tracks are set close to the curb of the 30-ft. roadway, leaving a single wagonway in the center, large enough to accommodate two lines of vehicles. The position of the tracks is such that the main longitudinal girders serve as outer-track stringers. The floor is a 6-in. reinforced-concrete slab carrying creosoted-wood blocks on a mortar bed. The track rails are ordinary T-rails, laid on shim plates (to make up for the varying thickness of the girder flange plates) capped with a ½-in. sheet of hard fiber to decrease noise and vibration.

In the independent highway viaduct, where the 32-in. floor-beams frame into the webs of the girders, the webs are slotted to pass a top flange tie strip for supporting the sidewalk cantilever bracket. In the combined highway

and railway section, the highway floor-beams are shifted toward the free side in such a way as to give approximately equal loading on the two columns.

Railway Viaduct

The railway viaduct, double-track throughout, has the same normal span lengths as the highway portion—45 ft. and 75 ft. The tower bracing in transverse planes is in a single panel; but although the greatest height of the viaduct is 71 ft., the structure is wide enough to give the diagonals a satisfactory slope.

Expansion is provided for in each 75-ft. span. The railway stringers of these spans are deeper than those of the tower spans, but near the expansion end the lower flange of the intermediate span is curved upward in ogee form to the level of the bottom flange of the tower-span girder, which gives sufficient depth for the expansion pocket. The riveting of girders and stringers to the floor-beams is the same at expansion points as at fixed points, so that no difference in the floor-beam web punching is required.

The design for the viaduct was made by Boller, Hodge & Baird, 145 Broadway, New York City, consulting engineers to the city of St. Louis for the municipal bridge. The estimated cost of the east approach, including real estate, is $2,750,000. The present contract covers only the fabrication of the steel, the price being in the neighborhood of $43 per ton delivered.

Aqueduct Outlet Cascades

By Burt A. Heinly*

The "cascades" of the Los Angeles aqueduct are at the outlet of the last tunnel on the aqueduct, 27 mi. northwest of Los Angeles. Emerging from the tunnel portal the full 20,000 miner's-inch flow of the aqueduct, in a stretch

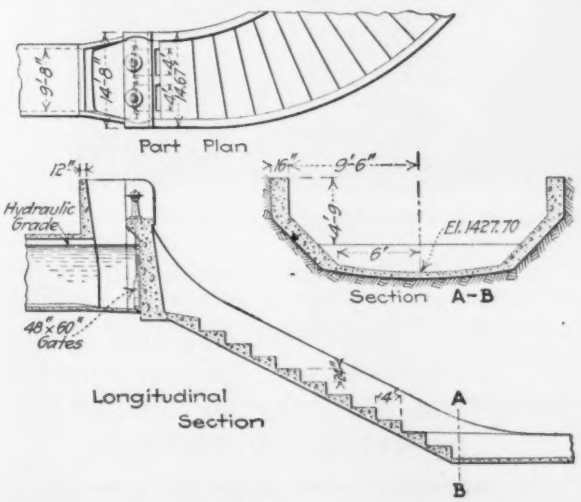


FIG. 1. DETAIL OF TUNNEL PORTAL AND STEPPED PORTION OF CASCADES

of 1037 ft. of rock-embedded masonry conduit, descends a distance of 167 ft. and produces the effect of a natural cascade.

The purpose of the structure is chiefly æsthetic although it has a high practical value in its thorough aëration of the water. Ultimately, however, it will be eliminated, as the total fall of 294 ft. from the outlet of the aqueduct to the high-water elevation of the prospective upper San Fernando Reservoir makes possible a hydro-electric development of 9685 hp.

A problem of design was to adapt the structure to the natural surroundings, within a 75-ft. right-of-way, simulating in concrete, so far as possible, a natural water course. The terminal tunnel has a height of 10½ ft. and a width of 9⅔ ft., with a flat slope of 2⅛ ft. to the mile, the exit opening from the precipitous slope of the range onto a spur or hogback.

Following the construction of a permanent road up the east side of the hogback, the face of the cliff from which the tunnel emerges was cut back 20 ft. to a hard con-

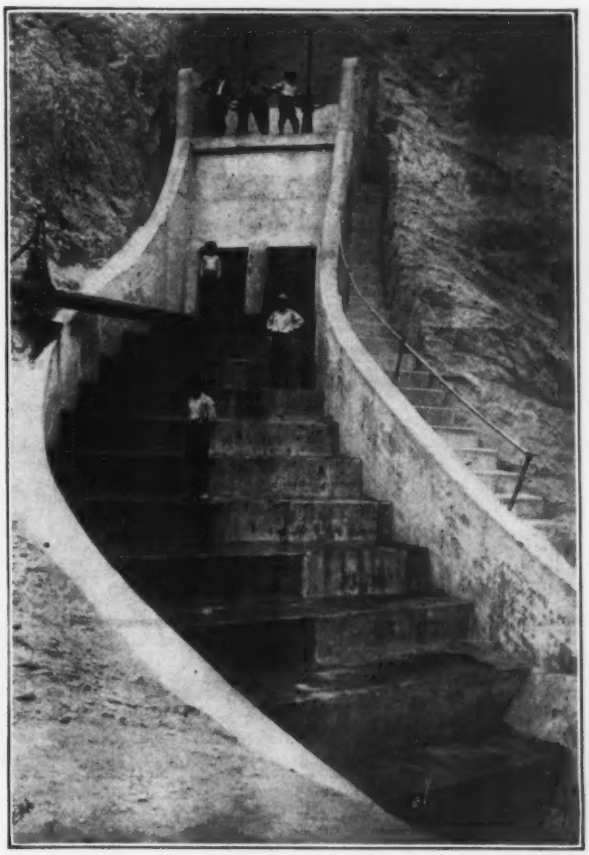


FIG. 2. TUNNEL PORTAL AND CASCADES HEAD

glomerate and a bulkhead of concrete built 3 ft. wide at the base to 2 ft. wide at the top with an overhang for the gate stands. The bulkhead was raised to a height of 13½ ft. above the floor of the tunnel. (See Figs. 1 and 2.) Besides containing two portholes (not shown in Figs. 1 and 2) 1 ft. high by 4 ft. wide, set 1 ft. below hydraulic grade, the bulkhead is 5 ft. forward from the mouth of the tunnel in order to provide for a safety overflow to relieve the pressure should the gates in the bulkhead ever be closed when the aqueduct is under flow. In the bulkhead are set two cast-steel sluice gates, 4 ft. high by 5 ft. wide, with bronze bearings, lifted by a 2¼-in. screw and operated by hand.

The first drop of 22 ft. in a distance of 49 ft. was taken care of by benching off the foundation in a series of 11 steps, each of 2 ft. rise., 4 ft. tread and ranging in length from 12 ft. at the top to 19 ft. at the bottom. The side walls to prevent overflow rise vertically 4½ ft. above

*645 South Olive St., Los Angeles, Calif.

the floor of the step and are of concrete, 16 in. thick, of 5½ parts of washed gravel to 1 part of Monolith cement. This cement—which was manufactured by the municipal cement mill and which as a municipal product was subjected to much criticism from certain quarters—was used throughout in the building of the "cascades." After being for more than a year subjected to flows under a very high velocity, it shows no signs of the wear or disintegration so freely prophesied.

From the foot of the stairs to the bottom of the cascade, the canal or conduit varies from 19 ft. in width and 4 ft. in depth to 72 ft. wide and 6 ft. in depth. This height at the bottom was made necessary to connect with the open-lined conduit at the foot of the cascade.

The grade for the 49 ft. of steps is 50 per cent.; for the next 750 ft. the canal varies in width from 19 to 37½ ft., with a grade of from 1.4 to 24 per cent.; for the remaining distance of 220 ft. the canal is from 37½ ft. to 72 ft. wide and has a grade of 30 per cent. On this last section the boulders were strewn as shown in Fig. 3. Considerable difficulty was experienced in the matter of elevation and location necessary to give the spectacular effect of a mountain torrent that was desired. The result is shown by Fig. 4. A total of 60 cu.yd. of boulders was required. These were selected to run about 1 ft. in diameter and were placed about 1 ft. apart. They were dropped into the concrete after it had been shoveled so that there was at least 1 in. of concrete between the base of the boulders and the subgrade. The concrete was then trowelled down. This left from 4 to 6 in. of the boulders protruding.

At the foot of the cascade, intersection is made with the open-lined conduit at an angle of 63 deg. Here almost all of the momentum and agitation of the water is taken up in a distance of 75 ft., the water entering the straight-away of the conduit as a smooth-flowing stream. Because of the great range of velocities in this open-lined conduit, in its length of 7975 ft., considerable allowance for difference in velocity-head had to be made. This was done without noticeable drop in the conduit by making long transitions in which the allowance for the difference in velocity-head in addition to the flow-grade was distributed along the transitions. In this way allowances of from 1 to 3 ft. difference in velocity-head are made which are unnoticeable to the ordinary eye.

FIG. 3. VIEW OF LOS ANGELES AQUEDUCT CASCADES BEFORE WATER WAS ADMITTED

The work was carried on under the direction of William Mulholland, chief engineer; E. A. Bayley, field engineer, and Henry L. Jacques, construction superintendent.

Unusual Activity in Canadian Power Development

The water-power industry in eastern Canada presents almost the only evidence of engineering and construction activity throughout the Dominion, where large building construction is generally halted. In Toronto a $3,000,000 union railway-terminal project, for which contracts were let, has been shut down (though disagreement among the interested railroads may be largely responsible), and the harbor development is not progressing as fast as had been anticipated.

In Montreal there is nothing new of size being undertaken except a $400,000 extension to grain elevator No. 1. Old works like the Sun Life building and the Canadian

Northern Ry.'s Mount Royal tunnel and terminal are going ahead rather slowly.

The construction being done stands out by its comparative isolation. In Quebec the union railway station, a $300,000 project, has been started and some steel is being put up; a large addition to the post office is being made and there is some river improvement. The Province of Quebec is taking advantage of the low cost of labor to build some 60 steel highway bridges, one of $150,000 cost; tenders on the work after the war began showed a decrease in cost from those before of from 15 to 20%. Railway activity seems confined to Government trans-continental lines and the great Quebec bridge, on which steady progress is seen. In Halifax the large railway and harbor development scheme, aggregating in cost possibly $4,000,000, is now well under way. The Welland Ship Canal enlargement around Niagara Falls is being prosecuted with some vigor. Both of these projects have been described in recent issues of *Engineering News*.

In view of the general depression, the increasing activity of the water-power companies is striking. Contracts have been let for $1,500,000 of work on the upper St. Maurice River storage and flow-regulation scheme. This will be one of the largest conservation developments on the continent, benefiting such large power concerns as the Laurentide and Shawinigan companies. A company known as the St. Maurice Construction Co. has been organized to carry on this work, the Shawinigan Power & Water Co. and Fraser, Brace & Co. (builders of the great Cedars Rapids development) being largely interested.

Construction work on the huge Laurentide hydro-electric station at Grand Mere, which ceased on the outbreak of war, has been resumed. The Shawinigan company has acquired the old Dorchester light and power company in Quebec, taking advantage of the financial difficulties of the latter, and will immediately run a 90-mile transmission line to Quebec.

The Quebec Streams Commission is asking for tenders on a $100,000 project on the upper St. Francis River. This is a storage and flow regulation project similar to that on the St. Maurice. Pulp mills will be the chief beneficiaries.

It is generally expected that construction work on the 500,000-hp. hydro-electric project on the Saguenay River above Quebec, backed by the Duke interests from the United States (Southern Power Co.), is about to be started, though no official information is obtainable. The preliminary work seems to be progressing, however. This development involves building a new town, at an anticipated expenditure of $5,000,000 or more, for the fertilizer and other electro-chemical industries here.

FIG. 4. EFFECT PRODUCED BY BOULDERS IN OUTLET TO LOS ANGELES AQUEDUCT TUNNEL

Part of the improvement in the power situation is probably in consequence of the manufacture of war materials. A great deal of it can be traced to the aluminum industry. The French and Scandinavian supplies are shut off and a great increase in the demands on American works has been felt. A small part of the aluminum demand is for military goods, like water bottles, motor-car and aëroplane parts, etc., but the greater portion is for the usual commercial purposes.

Owing largely to the demands of the aluminum works at Messina, N. Y., which take 60,000 hp. from the great Cedars Rapids plant near Montreal (described in *Engineering News* of Mar. 25, 1915, p. 566) the load on this station has jumped up to nearly full figure, though the station has been running only about eight months. Consequently extensions originally projected for construction several years from now will probably be made much sooner.

Field and Office

Drainage and Foundations on the Maine Post Road

The first state highway work undertaken in Maine, under the $2,000,000 appropriation made by the 1913 legislature, has been the building of a 21-mi. bituminous-macadam road from Portland to Brunswick. The contract for this entire work was let in 1914 to R. F. Hudson, Melrose, Mass.

On the first 6½ mi. of road out of Portland, an examination of the soil conditions during the spring of the year showed the necessity of special foundation and drainage treatment. There was a great scarcity of stone for filling subdrains, and it was decided to use a V-type gravel drain 30 in. deep in the center and a 4-in. tile drain with side outlets, in the bottom, where stone could not be

DRAIN TILE IN V-SHAPED GRAVEL TRENCH, MAINE POST ROAD

obtained. Of the whole distance of 6.63 mi., 1.33 mi. (20%) was built with a V-shaped gravel ditch and tile drain, 0.46 mi. (7%) with V-shaped ditch and stone drain, 0.67 mi. (10%) with an 8-in. stone base, and 1.36 mi. (20%) with a 4-in. gravel foundation.

A case of underdrainage was encountered just beyond the second mile, for about 100 ft., where it was necessary to resort to a combination of special stone drain and tile drain. The stone foundation was made 24 in. deep at the sides of the road and 30 in. at the center, while in the center and at a depth of 4 ft., a 4-in. tile drain was placed with side outlets of tile at intervals of 25 ft. This was found effectively to remove a bothersome and long-feared "honey-pot" of large area.

The highway work in Maine is in charge of a commission of three members, for whom Paul D. Sargent, former Assistant Director of the United States Office of Public Roads, is Chief Engineer.—William J. Dougherty, Portland, Maine.

Central Plant for Concreting Over Large Area

By F. L. Shea*

The concrete footings and basement wall and piers of the recently built Circle Building, New York City, were poured from a central plant, the layout of which is shown in the accompanying sketch and view. The shed sheathed with tar paper, as shown in the view, is for cement storage. The bin to the right of the tower in the same photograph is for gravel (500 cu.yd. capacity), and the one behind the tower is for sand (280 cu.yd. capacity).

The charging hopper of the mixer is on a level with the platform of the sand and gravel bins. Directly above this hopper and extending to the level of the floor of the cement storage house is a hopper lined with galvanized iron, into which the cement is discharged. When the bins were full the sand and gravel were shoveled to the mixer hopper; when material in the bins was level with the platform or below it, the sand and gravel were wheelbarrowed to the hopper. To avoid this operation the bins were kept filled above the platform level until the work no longer required storage.

The cement storage house was built of tongue-and-grooved boards, and was sheathed on the outside with two-ply tar felt, well lapped and secured with wood battens. The roof was covered with felt secured with roofer's nails and disks. To prevent the cement from coming in contact with rain-water running down the back wall and seeping in at the joints of felt and sheathing, a V-shaped gutter was provided at the rear and lined with felt.

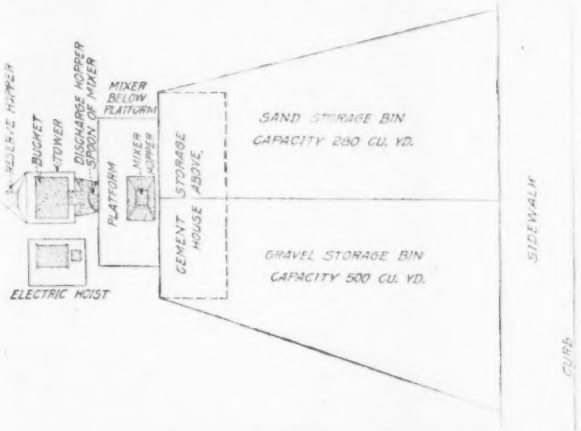
The trucking of material was done with a view to avoiding unnecessary handling. The top of the bins was level with the sidewalk and the sand bin was planked over to permit driving over and dumping directly into it through trap doors. The gravel bin was not covered, material was discharged into it from the top of the sand bin. The floor of the cement house was on a level with the truck platform, so that the cement could be unloaded from trucks into the house. The rear of the cement house opened on to the cement hopper.

The ¾-yd. bucket in the tower could be lowered into a pit 5 ft. below ground level, and the spoon of the discharge of the mixer was but 2 ft. above ground. This spoon delivered into a wooden hopper holding a ¾-yd. batch, so that while one batch was being mixed another was being discharged from this reserve hopper to the bucket and a third was being fed into the hopper of the

*Superintendent of Construction, Columbus Circle Construction Corporation, 2 Columbus Circle, New York City.

mixer—three batches moving at one time. The bucket was hauled up to the level of the chute hopper by the electric hoist, and was automatically tripped.

The reserve hopper was provided with a pin-hung discharge chute, which was operated by the bucket. As the



LAYOUT OF CONCRETING PLANT AT SITE OF CIRCLE BUILDING

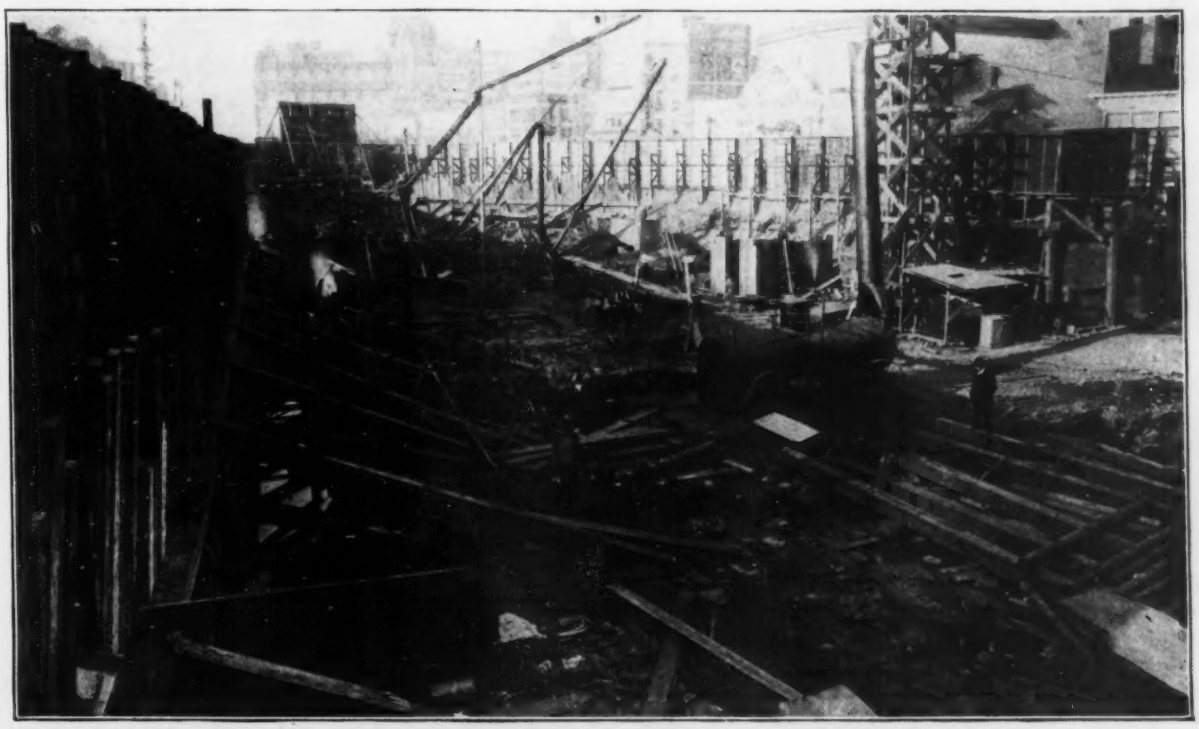
bucket ascended in the tower it turned this chute up and held the concrete in the reserve hopper, and when the bucket descended and passed the end of the chute it pulled it down and allowed the bucket to be filled. Later on, as the work progressed, the reserve hopper was abandoned and the concrete was fed direct from mixer to bucket by means of a galvanized-iron pipe slide chute.

It was found that the drippings from the reserve hopper settled in the pit at the bottom of the tower and interfered with the proper operation of the bucket. When the latter was discharging at the rate of a batch a minute this accumulation necessitated stopping the mixing and discharging at least three times in eight working hours in order to clean the pit. This cleaning operation took from five to eight minutes, which offset to a large extent the time saved by having a reserve batch.

A second reserve hopper was secured to the base of the tower, adapted to be filled by a length of chute to receive wheelbarrow loads. The purpose of this second hopper was to provide concrete for filling the minor pier holes while the chute was being shifted.

The chutes were in 30-ft. sections, the intersections being supported by ginpoles. This method was considered to be more satisfactory than using A-frames, as is ordinarily done. It permitted easy handling of the chute sections and shifting without disconnecting. The steel A-frame bracket which supports the first or tower chute was fixed in position so that the chute would be held permanently at the 65-ft. elevation during the entire course of the concreting. This elevation was maintained even when the concreting was at a point very close to the tower, making the descent of the concrete rapid. The chuting distance varied up to 200 ft.

Expense-Money Advances to Assistant Engineers—An engineer in New York City with a number of assistants who spend more or less time traveling has adopted the following means for keeping them supplied with expense money: To each assistant is advanced $50, for which he gives his note. At the end of each week the assistant puts in his expense account for the week. On the following Monday morning a check is given him for the account as approved, thus restoring and maintaining his $50 advance. This practice obviates what is a sore point with a large number of engineering and other employees throughout the country who are called upon to advance out of their own funds money for traveling and other expenses. Of course in some cases $50 would be an insufficient advance, but it serves to illustrate the principle. It may be added that one case has been reported to us in which a young man in the Federal employ was obliged to advance $600 personally for expenses before he got any of the money back.



GENERAL VIEW OF PLANT AND SITE SURROUNDED BY FOUNDATION-WALL FORMS

Engineering Work Preliminary to Pavement Construction

The engineering work preliminary to pavement construction or renewal varies in different cities. Generally a center line survey with cross-sections every 25 or 50 ft., with specifications, is about all the information given the contractor to bid on. A great many details are usually left to be decided by the supervising engineer, who is often called upon to do considerable supplementary survey work, such as giving lines, grades, etc. More often than in other branches of engineering work, the details of design, except at complicated side-hill crossings, are neglected.

Detail Survey and Design

In St. Louis, Mo., the Board of Public Service has organized a division of design—sewers and paving—one of the objects of which is to reduce to a minimum the engineering work required after the pavement construction has actually begun. The purpose is to furnish the contractor and supervising engineer with so much preliminary detail that there will be no call for survey or engineering work other than inspection and supervision, after the construction of the pavement has been started.

The payment for street-improvement work in St. Louis, both new construction and renewal, is by assessments on abutting property. Hence the first step is the preparation of a property map of the benefit district. For pavement work one third of the cost is assessed against the frontage on the improvement and two-thirds pro rata against the area within the benefit district, which usually extends half way to the next public street. For sewer work the assessment is by area. This map, of which Fig. 1 is a typical section, is compiled on a scale of 60 ft. = 1 in., chiefly from the record plans on file in the city. The original lot subdivisions are shown as well as their present division and ownership. Discrepancies in street lengths are adjusted if necessary after making the detail street survey, which is described in the following. While of considerable assistance to the contractor in making his estimates, the primary purpose of the detail plan is to facilitate the work of the construction or supervising engineer. A study of a section of a typical plan (Fig. 2) will show that the field engineer is relieved as far as practicable of all calculations, small details, etc., which would require office work on his part. This allows him to give his whole time to supervising the work of construction; and of course has made it possible greatly to reduce the field force, although it has correspondingly added to the designing staff. While the ultimate economy of the new method is not yet proved, very satisfactory results have been achieved thus far.

Preliminary to drafting the plan, a very complete survey of the street is made, and the corners of all intersecting streets and alleys are definitely fixed by reference to permanent structures or by setting monuments. All telegraph or telephone poles, lamp posts, fire hydrants, sprinkling hydrants or standpipes, valve boxes, sewer in-

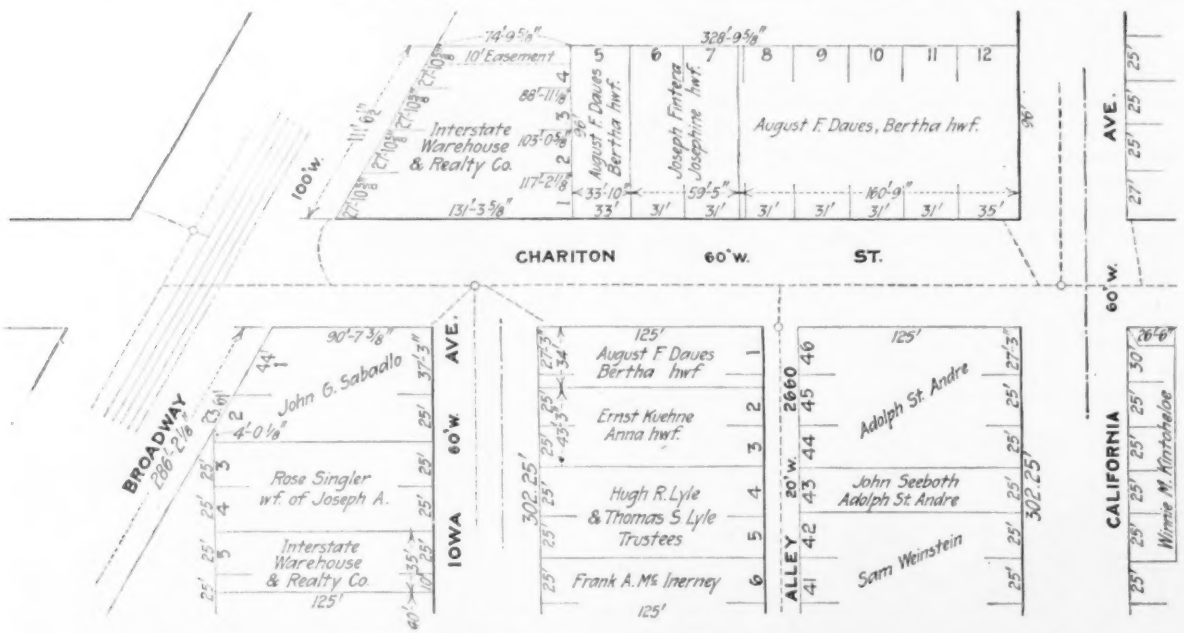


FIG. 1. ASSESSMENT MAP OF BENEFIT DISTRICT, PAVING IMPROVEMENTS, ST. LOUIS, MO.

lets, manholes, trees, curbs set on intersecting streets, street-railway tracks, sidewalks, and all else that probably will be affected or need adjusting in any way because of the new pavement construction are located and recorded in this preliminary survey.

With this information at hand the final details of the pavement design are worked out. The completed plan (Fig. 2) on a scale of 40 ft. = 1 in., contains all the record notes pertinent to the location of the street lines, the established grades, elevation of benchmarks, crown of pavement at various cross-sections, details of corners of intersecting streets, summaries of curbing required, inlets and manholes to be built, rebuilt or adjusted, water or gas mains to be lowered, pole lines to be adjusted, obstructions to be removed, and a preliminary estimate of the cost of construction.

This system of handling the pavement work, whether more economical in actual cost or not, has resulted in distributing the work of the engineering staff of the city

uniformly throughout the year, and gives an opportunity for greater accuracy, as well as furnishing valuable record plans of street conditions and changes.

Under the new city charter of St. Louis, the public works are controlled by a Board of Public Service, of

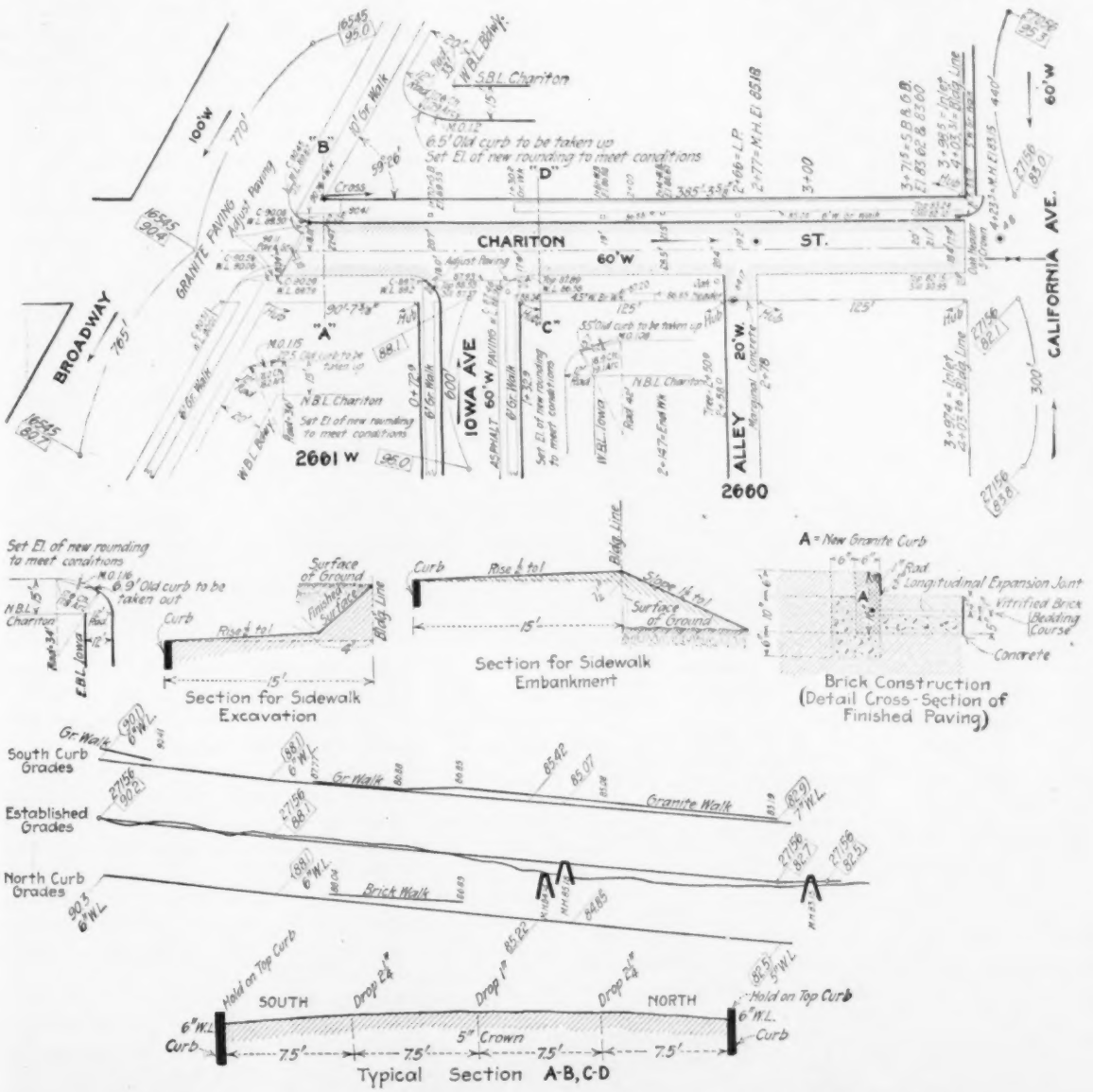


FIG. 2. PLAN, PROFILES AND CROSS-SECTIONS FOR PAVING IMPROVEMENT, ST. LOUIS, MO.

which E. R. Kinzey is President. The chief of the division of sewer and pavement design is W. W. Horner, and S. Sammelman is in direct charge of the paving section.

Cardboard Templets for Laying Out Structural Work

The practice of laying out rivet-holes in structural steelwork with the aid of wooden templets is pretty thoroughly established in this country. The Templet Co., of Ashtabula, Ohio, is making a promising attempt to change this practice by substituting cardboard for the more costly templet lumber.

Cardboard templets have been used only for small pieces, such as gusset-plates. Long cardboard strips, as required for flange, angle and girder templets, are too troublesome to handle. The improvement introduced by H. B. Ash, of the Templet Co., consists of a new method of preparing, handling and applying cardboard for all lengths of templets.

Preparing and Handling

Experience has shown that cardboard expands and contracts, in consequence of moisture variations, about $\frac{5}{16}$ in. every 7½ ft. To eliminate this troublesome action the concern has developed a treatment by which the cardboard is finished with a sort of varnish gloss. It is claimed that this prevents all change of dimensions.

For girder web-plate templets, up to 8-ft. width and 30-ft. length, cardboard sheets of exact width are supplied by the company in rolls of 12-in. diameter, from which

the templet-maker simply cuts off the required lengths and at once proceeds to locate the rivet-holes.

For angle flange-plate and bar templets, one edge of a long, narrow piece of cardboard is inserted between a pair of maple clamping strips, which hold and stiffen it, and enable the cardboard to be handled conveniently in all lengths, besides serving as a guide in locating the holes. The clamping screws, spaced 18 in. apart, are so seated as to separate the clamping strips positively when the screw is turned in the release direction. Short pins in the jaw of the lower strip take hold of the cardboard and insure against its slipping. The strips may be made with a ⅛-in. scale marked on them to facilitate locating the holes; but on long lengths it is preferable to work with a steel tape. The width of the gripping jaws for holding the cardboard is ⅞ in., and cardboard for angle and flange templets is made regularly ⅞ in. over the even width; for example, 3⅞ in. wide for a 3-in. flange.

Applying the Templets

The templets are laid upon the iron to be marked in the same way as wood templets, with the advantage that the frame serves as a guide and rests upon the flange, and it is unnecessary to turn the iron to mark the opposite flange as is the case with a wooden templet.

The greatest saving with cardboard templets is in the templet-maker's time, as he is using a material which is more easily worked. On this point Mr. Ash gives the following figures:

Of a 15-ft. templet for a 6x6 angle, the total cost is about 35c. for wood and 17c. for cardboard. The saving of 18c. includes 15c. saving in cost of material (at $45 per M ft. for lumber and $8 per M lin.ft. for 6-in. cardboard), and 6 min. or 3c. saving in labor (elimination of sawing and trimming, while punching holes in cardboard can be done twice as fast as drilling them in wood).

For a 42-in. web-plate templet 15 ft. long the total costs are about $1.20 and 88c.; there is a 12c. saving in material cost and a 36-min. or 20c. saving in labor.

Handling Steel Centers for Concrete Arches

By Harold E. Ketchum*

The centering for the Detroit-Superior High Level Bridge was complicated by the number of different rises and spans of the arches. Arches 6, 7 and 8 have the same span and have been centered with similar three-hinged steel arches supported on steel columns (Fig. 1). Arches 2, 9 and 10 are shorter and are being centered by removing one section of the standard arch-truss and placing a new end post. Arches 1 and 5 will take the standard centering and arch 3 will have an extra section added to the trusses previously used. The remainder of the arches are being centered with timber except the arch over the Erie Railroad, which is provided with structural reinforcing strong enough to act as a support for the concrete.

At the crown of the steel centers a toggle adjustment provides a simple and satisfactory means of striking. It gives a clearance of 6 in. at the crown and about 1 in. at the haunches. The toggles are also used to bring the arches to proper grade before concreting.

The haunches of the trusses are pin-connected to cast-steel and structural-steel shoes having a wide base to roll on. Four-inch steel rollers in nests of five are placed under the shoes. Three 12x12 oak timbers protected by a ¼-in. steel plate and supported by sectional steel columns serve as a runway on which to move the centering.

Erecting the Centers

The steel trusses arrived on the job in sections on cars. The unloading and handling during the assembling were done by the cableways. All parts are bolted together (¾- and ⅞-in. bolts). A tower of 8x8-in. posts and 2x8-in. braces is placed to support a pair of half arches near the crown of one pair of trusses while the opposite trusses are erected and pins driven. Each truss weighs 12½ tons and while the rated capacity of the cableways is 8 tons there has been no difficulty in handling the heavier loads.

The cables of the cableways are located midway between each pair of ribs and the trusses had to be erected under the cables. When the two steel arches forming the centering for one concrete arch rib are erected, the end pins are connected with cables and turnbuckles. Enough tension is brought to bear on the cables with the turnbuckles to raise the centering off the tower. The centers are then jacked over into position, two 10-ton track jacks being used.

When the steelwork for both ribs is in position, cross-bracing is placed between the pairs of centers, and diagonals of the turnbuckle rods in the lower chord. When

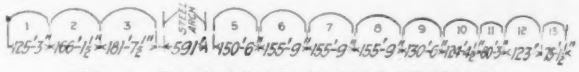


FIG. 1. DIAGRAM OF ARCHES, DETROIT-SUPERIOR BRIDGE

the trusses are braced together they make a stable unit, but as a matter of safety a ⅝-in. wire-rope guy is fastened on each side of the crown and secured to deadmen with turnbuckle connections for adjustment.

Upon striking the centers after having concreted one pair of ribs they are moved as a unit to the other side of the bridge into position for concreting the other pair of ribs. A hoisting engine and five-part blocks are used in moving. When the trusses have been struck for the last time they are rolled between the arch ribs and supported by turnbuckles hung from steel girders resting on the arch ribs, while the pins are driven out. The cableway is then used to remove the trusses.

The average time of erecting one complete set of centering for one rib is about 6 hr. To roll the trusses from one side of the bridge to the other, the distance traveled being about 46 ft., requires from 4 to 8 hr.

The Hunkin-Conkey Construction Co., of Cleveland, Ohio, is the contractor for this part of the bridge work.

*Superintendent, Hunkin-Conkey Construction Co., Cleveland, Ohio.

A Comparison of Railroad Wages in 1871 and 1914 is made in a bulletin issued by the New York, New Haven & Hartford R.R., as follows:

	1871	1914
Average monthly pay:		
Passenger engineers	$90 and $100	$131.39
Passenger firemen	50	75.35
Passenger conductors	100	133.73
Passenger brakemen	45 and 50	78.07
Freight engineers	$75, 85 and 90	177.51
Freight firemen	45 and 50	92.52
Freight conductors	85	118.88
Freight brakemen	45 and 50	82.10
Av. rate per pass., per mile	$0.02538	$0.01712
Decrease, 32.5 per cent.		
Av. rate per ton of freight, per mile	.04295	.01415
Decrease, 67 per cent.		

It is to be recalled that payments in 1871 were on a paper basis and not on a gold basis. Taking that into account, the increase in wage rates is even greater than the above table indicates.

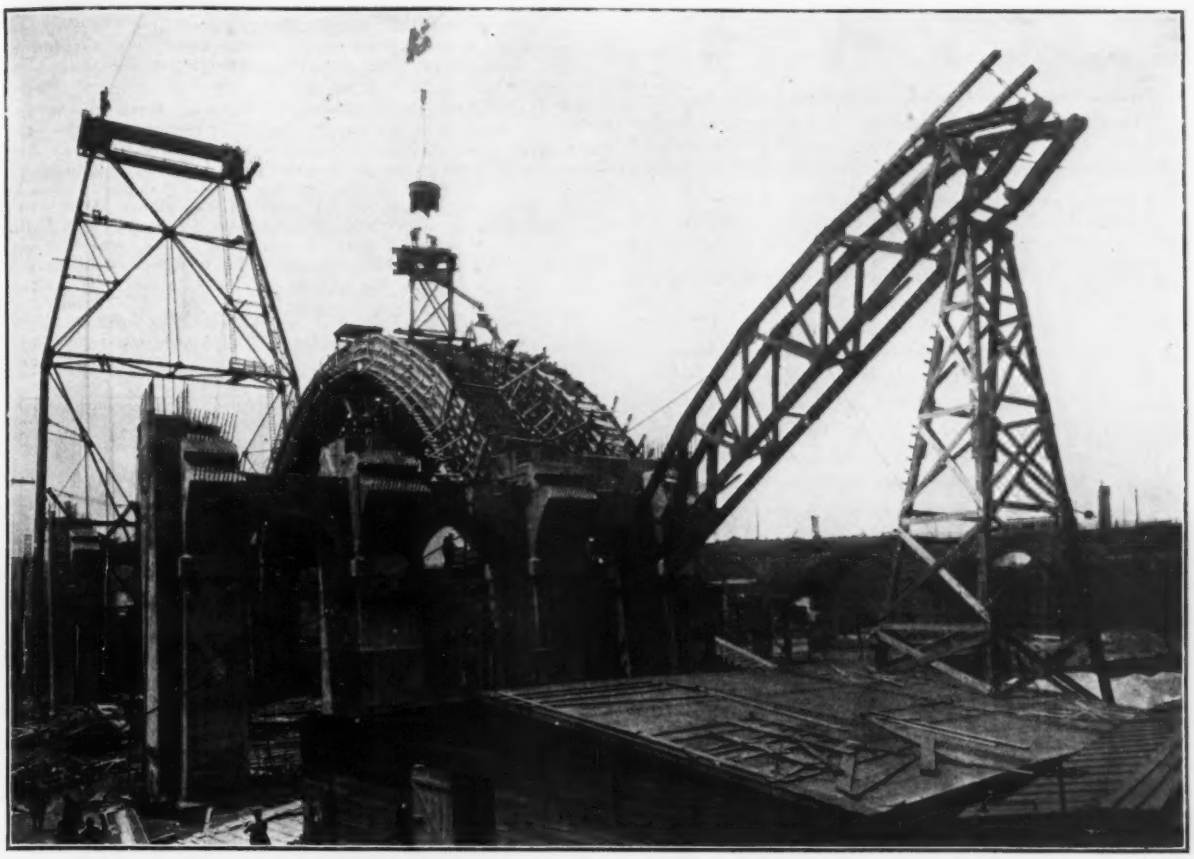


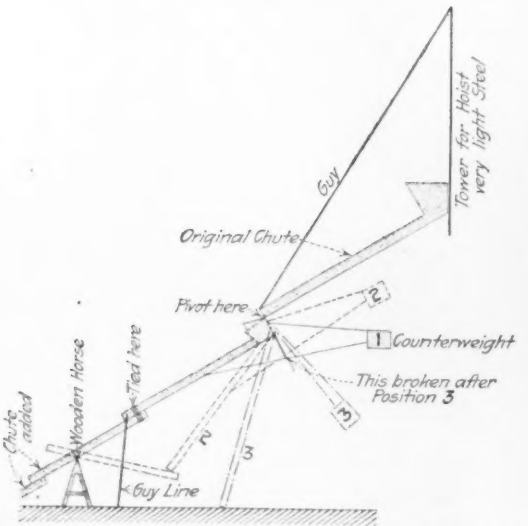
Fig. 2—Setting halves of the three-hinged arch centers on temporary tower

Fig. 3—Cableway placing last piece of centering for a pair of ribs

FIGS. 2 AND 3. ERECTING CENTERS FOR CONCRETE ARCHES OF THE DETROIT-SUPERIOR VIADUCT

NOTES

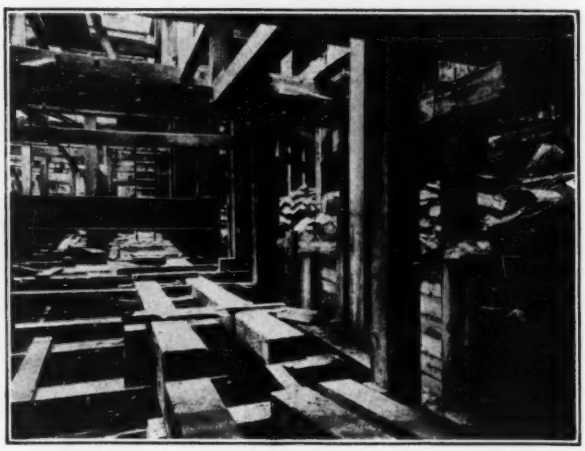
Neglected Turning Moments in the construction of a concrete distributing chute recently caused a Cleveland, Ohio, contractor considerable annoyance and expense. The manufacturer of the chute supplied a light skeleton steel tower with two lengths of chute, one attached to a carriage on the tower which could be elevated to suit the different floor levels the second pivoted to the end of the first length and balanced by a counterweight. These two lengths of chute, however, were not long enough to reach across the building,



COLLAPSE OF CONCRETING CHUTE FROM NEGLECT OF A LITTLE COMPUTATION

and the contractor added two lengths as shown by the full lines in the accompanying sketch, partly supported from the tower and partly by a wooden horse. The first batch of concrete wrecked the chute, for the counterweight was not sufficient to support the weight of the wet concrete when it ran into the first of the added lengths of chute. The structure assumed the position indicated by the dash lines marked 2. After hanging a few minutes in this position the counterweight arm commenced to bend, reducing its lever arm, the horse was pulled over and the chute and counterweight assumed the position marked 3. This accident resulted in about a 4-hr. delay in placing concrete and a lot of unnecessary labor, all of which might have been avoided by the use of some intelligence in supporting the chute.—A. D. Williams, Cleveland, Ohio.

Use of Horizontal Sheeting in Subway Work—Horizontal sheeting has been used in a number of instances as the back form for concrete in the construction of the Flatbush Ave. subway, Brooklyn, N. Y. The soil is firm sand, clay and boulders. At one point where the excavation was very close to the building line, horizontal sheeting was placed all the way to the bottom of the cut, which was 30 ft. deep at this point. The timber sheeting was of the usual 2x8-in. size and was braced horizontally every 5 ft. In placing the sheeting it was guided and held by 6x10-in. vertical rangers or posts, which were driven down as the sheeting was placed. These rangers were spaced 5 ft. apart. In shallow cuts, such as where the six tracks are depressed, horizontal sheeting was placed and held every 5 ft. by two 6x12-in. bolted continuous cross-



HORIZONTAL SHEETING ALONG CUT FOR DEPRESSED TRACKS

braces or needles butting directly against 4x10-in. vertical rangers placed flat against the horizontal sheeting. The work is being done by the Cranford Co.

A Convenient Time Card is that shown in the accompanying illustration. It was devised to prevent dispute with the day laborers employed by the maintenance division of the Pennsylvania State Highway Department over the amount of pay due them from the state. The men are employed usually in small gangs, and each day the timekeeper or foreman punches the card for the date and number of hours worked. The rate of pay is also shown in a similar manner. The workman keeps his time card as a certified statement of the pay due until the semimonthly pay day, when it is surrendered and becomes a signed receipt for the files of highway department. For purposes of identification the workman makes a signed statement on the back of the card certifying to the correctness of the record. He also has a numbered brass check which he must show before cashing his time card. This time card does not replace the usual time-book record, but is supplementary to it, giving a check on the timekeeper's summaries. The time card must be approved and signed by the foreman before it becomes valid. This simple device has proved quite successful in use and has prevented many misunderstandings. George H. Biles, former Maintenance Engineer, now Second Deputy Commissioner of the Pennsylvania Highway Department, devised the system and card.

In accepting this card, I declare that I am a citizen of the United States.

Name ..... Post Office Address .....

Route No. ..... County ..... Township ..... Classification of Labor .....

Appl. No. ..... County ..... Township ..... Labor .....

Check No. ..... Pay Period ending ..... Pay Roll No. .....

16	17	18	19	20	21	22	23
1	2	3	4	5	6	7	8
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12

Rate .....
Hours .....
Amount .....

STATE HIGHWAY DEPARTMENT
Maintenance Division

Rate per hour					
5	6	7½	8	9	10
12½	15	16	17½	20	22½
25	27½	30	32½	35	37½
40	42½	45	50	52½	55
60	65	70	75	80	100

24	25	26	27	28	29	30	31
9	10	11	12	13	14	15	
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12

In filing this card each employe must certify to the correctness thereof by signing the form on opposite side. Any attempt to deface, mutilate or fraudulently punch this card will be dealt with to the full extent of the law, and the card will be declared null and void and payment withheld.

LABORERS' TIME CARD, PENNSYLVANIA STATE HIGHWAY DEPARTMENT

Editorials

Art in Water-Works Design

Few if any public works designed by the engineer afford such numerous and varied opportunities for artistic expression as those devoted to the water-supply of cities. That these opportunities were eagerly grasped and effectually improved in ancient, medieval and early modern times is shown by aqueducts, fountains and wells in various parts of the world.

With the advent of the thousands of water-works of the later modern type, made possible by pumping machinery, by iron, steel and improved forms of wood pipe, and by iron and steel standpipes and tower-tanks of the same materials or of wood, there came an era of water-works structures that needed no excuse for ugliness because they were buried or at most but rarely seen, on the one hand, and on the other, of structures whose inexcusable ugliness rose heavenward in the sight of thousands. Exceptions to these examples of quite unnecessary ugliness were occasional masonry-inclosed standpipes and tanks and here and there a pumping station which, either through sheer fitness for their purpose or else by chance, or again and more rarely through careful design, were pleasing to the eye.

The increasing demand for water storage on a large scale to keep pace with the enormous city growth of the last half century, has caused the erection of thousands of masonry dams, small and large, throughout the civilized world. Most of these dams have been designed in blissful ignorance of everything entering into what, for want of a better term, may be called architectural composition. As a rule, structures so designed are bound to fall short of their highest possibilities, yet many of them may nevertheless possess much artistic merit because of that sheer fitness of form to function which has already been mentioned.

How many times architects have been called in to aid in the design of dams would be interesting to know; as a guess, not many—at least not in this country.

Unquestionably the most notable attempt to treat a dam in accordance with architectural principles is the Kensico Dam, described in detail elsewhere in this issue. For reasons, methods and results, and much of value about the underlying principles of architectural design as applied to dams, the interested reader is referred to the article just mentioned.

Reverting now to tanks and towers, a class of water-works structures which are employed more to insure pressure than to provide storage, changes in purely structural design, such as curved for flat-bottomed steel tanks, and the growing use of reinforced concrete for standpipes and for elevated tanks, have in themselves wrought marvelous improvements in the looks of water tanks, towers and standpipes and have made further improvements easily possible.

One opportunity for art in water-works design there is which has gained considerable recognition but deserves far more. It comes through the heightening or, if need be, the creation of landscape and waterscape effects. An interesting example is afforded by the cascades of the Los Angeles Aqueduct, illustrated elsewhere in this issue. Landscape architecture, too, is a notable feature of the immediate surroundings of the Kensico Dam, already mentioned. Effective landscape work has also been done around some of the reservoirs of the Massachusetts Metropolitan Water District. To mention only one foreign example, nature and man have done nobly by the water-storage reservoirs of Leicester, England.

A typical example of lost opportunity which painfully impresses at least one person every time he passes by daylight over the horseshoe curve of the Pennsylvania R.R. is the bare and ugly embankments of the Altoona water-works reservoirs. A small expenditure there, under skillful direction, would at least ameliorate the blot on the landscape now caused by the dams, and perhaps bring these into harmony with the natural landscape and the pleasing effect of the water surfaces of the two reservoirs.

New England Water-Works Convention Attractions

An unusual program is offered by those responsible for the success of the annual convention of the New England Water-Works Association which is to be held in New York City, Sept. 7-9. For many years past the September conventions of this association have consisted of relatively few papers, an excursion or two and a considerable amount of open time. This year there are on the program 22 technical papers and addresses and one committee report, distributed through five sessions. In addition one afternoon will be devoted to an excursion by water and another to the Kensico Dam of the Board of Water-Supply of New York City—the architectural features of which are described elsewhere in this issue.

One reason for the unusually large number of papers this year is that the program includes two sessions for superintendents with six papers and discussions at each session. Another reason is that particular pains have been taken by the program committee to present to the visitors a number of interesting features of the design, construction and operation of the water-works of New York City. The range of subjects is almost as notable as the number of papers. And the subjects are live ones, too.

As may be judged from the foregoing statement, there is reason to anticipate a large and enthusiastic gathering of water-works men in New York City next week. The program offers instruction and entertainment a-plenty for each and all. The city in which the meeting is held has attractions of its own besides those in the water-works field which are so liberally represented on the program. Best of all in many respects will be the unlimited opportunities for quiet personal exchanges of water-works and other experiences and for the enjoyment of the good fellowship that prevails at all the water-works conventions, of whatever name and in whatever place.

It hardly needs to be said in conclusion that the New England Water-Works Association is local only in name. Its membership is well distributed throughout the United States and Canada. Although there may continue to be, for a while longer, more than one water-works association in America, there is only one water-works fraternity and all its members will be welcome in New York next week.

The Unstable Earth Fill

It seems almost like rubbing it in to call attention just now to the defects in the design of the earth section of the Galveston Causeway. A careful examination of periodical literature does not show a single protest against the protected earth fill which joins the short concrete arch section to mainland and island, on both sides nearly a mile away. As far as the records go, this part of the design was considered as reliable as the long line of concrete arches on their wooden piles. Today, in the light of its so complete failure, the truth is quite obvious. No earth slope can long stand up under water overflow. Protection in the way of paving or revetment will put off the evil hour, but sooner or later the initial crack develops and through the opening so offered the final destruction is only a matter of time.

This fact is well-known to builders of earth dams and river levees. Doubtless it was appreciated by those responsible for the causeway, though its importance must have been outweighed by considerations of economy or by an unwarranted trust in the calmness of Galveston Bay. The integrity of the concrete sheetpiles which survived the terrific assault of the hurricane and the stability of the concrete arches testify to the workmanlike manner in which the structure was built. It seems a shame that the extra cost of a rock fill was not ventured or a permanent pile-and-girder design of some sort utilized. At least some effort could have been made to avoid that unprotected ballasted roadway which was undoubtedly the "Achilles heel" of the whole structure.

Truly, as the poet says, "Hindsight is better than foresight."

Contract With an Inducement for Economy

Some time ago this journal received from the chief engineer of a prominent Western railway an inquiry as to whether any form of percentage contract had ever been tried under which the contractor would receive the actual cost of the work plus a percentage which would be so graduated that he would have a strong financial inducement to make the cost as low as possible.

It has been learned that such a contract was framed for the construction of the Cambridge subway, which was built for the Boston Elevated Railway Co. by the contracting firm of Hugh Nawn, of Boston. The contract between the company and the contractor, according to information furnished by C. S. Sergeant, Vice-President of the company, contained the following provision for payments:

The contractor received in the first place the actual cost of the work plus 10% of such cost. Upon the final completion of the work, the total cost, including the 10% paid to the contractor, was ascertained and compared with the estimated cost as determined by the engineer of the company, provision being made, in case this estimate was unsatisfactory to the contractor, for revision by a board of referees of three engineers. If the total cost of the work exceeded the estimated cost, then one-fourth of this excess was deducted from the 10% to be paid the contractor. In case, however, the final cost of the work was less than the estimated cost, the contractor was entitled to receive one-fourth the amount saved.

In computing the cost of the work, the cost of machinery, tools and appliances purchased for and used upon the work was included, less the value of such machinery, etc., at the conclusion of the work, to be agreed upon between the contractor and the company. This did not include, however, the small tools and supplies used, the entire cost of which was charged to the work.

A general and well-founded objection to the carrying on of contract work on a percentage basis is that the contractor has no incentive to practice economy in the conduct of the work. On the contrary, the more costly it is the greater is his profit. The use of the percentage form of contract, therefore, is generally limited to firms of well-established reputation which are carrying on work for private corporations which are not bound by the legal restrictions governing most public work as to advertising the contract and letting it to the lowest bidder.

Under the plan described, however, there is no reason apparent why such a form of contract might not be made applicable to the carrying on of public work let by open bidding. Those bidding on such a contract would state in their bid the percentage they would accept in addition to the actual cost of carrying out the work according to specifications, provisions for deductions from, and additions to, that percentage being included according to the plan outlined or such other plans as might be deemed advisable under the local conditions.

Everglades Drainage Problems and Florida Rainfall

Anyone who witnessed the destruction wrought as the result of a rainstorm of less than 6 in. at Erie, Penn., as reported in detail in *Engineering News*, of Aug. 12, can form some idea of what an inundation must result from a rainfall of over 15 in. in 24 hr., reported at St. Petersburg, Fla., on page 428 of last week's issue. The Florida storm, however, fell in a comparatively level country. St. Petersburg is on the Gulf Coast, with no opportunity for such a flood to gather as swept down the steep slopes on the upper part of the Mill Creek drainage basin at Erie.

The Florida rainfall is of especial interest, however, in connection with the much-discussed project for the drainage of the Everglades. In the various engineering reports that have been made upon this project, two points have been emphasized. One is that in any system of drainage canals from Lake Okeechobee, or from the Everglades itself, suitable provision should be made for control gates, so that the level of the lake and of the ground water in the swamps may be prevented from falling too low in times of long continued drought. A special reason for this precaution is that at such times danger exists of fire getting into the dried-out upper portion of the swamp and causing widespread damage.

The second point made in the engineering reports upon the project has been the necessity for providing drainage canals of sufficient capacity to take care, to a reasonable extent at least, of the large runoff due to the heavy rainfalls which often occur in this section and which flood the canals.

Both these recommendations by engineers receive additional force in the light of recent events in the Everglades. According to the best information, Lake Okeechobee was last spring at the lowest stage ever recorded. The canals from the lake to the ocean which have been already completed contain no provision for checking the flow of water, and during a long period of dry weather the lake waters were drained away until a large area of the lake bed was bare. The Seminole Indians, who are accustomed to navigate the lake with light canoes, had great difficulty in getting across it.

Following this stage of unusually low water have come the recent storms. It is stated that at the time of the recent 15-in. rainfall in St. Petersburg, a heavy rainfall was general throughout Florida and particularly severe in the southern portion of the state. As a result Lake Okeechobee is reported at its highest stage. The drainage canals thus far completed are inadequate to carry off the water. Lands which were expected at this time to be drained and available for agriculture or town building are reported to be under 5 to 6 ft. depth of water. It is a common experience of engineers to find their recommendation of provision for extreme rainfall and runoff in hydraulic works falling on deaf ears. The widespread floods of the present season are a valuable object lesson to the public that engineers' recommendations as to provision for floods are based on practical realities and not on pure theory.

Letters to the Editor

Initial Tension in Rivets

Sir—In the fourth paragraph of a letter from Edward Godfrey, of Pittsburgh, printed on p. 184 of your issue of July 22, the following statement is made in regard to rivets in tension: "Pulling on the head of a rivet does not increase the stress on the rivet, but relieves the pressure on the plates," etc.

This statement seems to me to be in error, as follows: The theory of the initial tension is that the rivet in cooling contracts so that the distance between its heads would be less than the combined thickness of the plates joined, if an equal (or greater) resistance to compression were not offered by the plates. The initial stress is therefore due to the reluctance of the plates to reduce their combined thickness, the air and paint between them contributing slightly to the thickness. Any strain which tends to increase this combined thickness—such as tensile pulls—will obviously increase the stress.

In the symposium, of which Mr. Godfrey's letter is a part, I have not noticed any reference to the fact that the actual initial tension in a hot-driven rivet is very materially reduced by the simultaneous shrinkage of the plates. The heat from the rivet is very largely absorbed by that part of the plates adjacent to the holes, and any riveter can tell you that the plates get hot—hot enough to expand—nearly as hot as the rivet itself at the finish of driving. In cooling, both rivet and plates contract, the rivet only slightly more than the plates. Many a rivet is passed for "tight," on a hammer test, whose shank fills the hole and whose heads only barely touch—quite a proper condition, it seems to me.

Like Mr. Godfrey, I believe that rivets in tension, if used in properly designed details and only used where essential, are not entirely to be forbidden, as the initial tension (except in long rivets) will not be extremely high in rivets driven in the field.

IRA W. DYE.

872 N. Farson St., Philadelphia, Penn., July 24, 1915.

Water-Ballast Tanks and the "Eastland" Disaster

Sir—I have noticed with interest your comment on the water-ballast tanks of the "Eastland." It is true that when they contain water they tend to lower the center of gravity of the whole vessel; but unless the tanks are filled, the presence of water in them would in many cases decrease the positive metacentric height, righting moment and stability, the exact condition depending on the relationship between the vessel's beam and water line of flotation and the ballast water surfaces.

The metacentric height is represented by

$$GM = \frac{I - GB \times V - \Sigma i}{V},$$

In which I is the moment of inertia of the water plane of flotation, GB the distance between centers of buoyancy and gravity, V the volume in cubic feet of displacement and Σi is the summation of moments of inertia of water surfaces inside, such as water-ballast tanks, boilers, bilges, etc. It will thus be seen that in some cases the partial filling of water-ballast tanks may be "the last straw that breaks the camel's back."

The statement in your issue of Aug. 5, that the "Eastland" was in the habit of listing to one side or the other, is interesting to say the least. This condition is frequently observed in cargo-carrying freighters when light and with practically no coal on board. One often sees in New York harbor, a freight steamer high out of the water with a list to one side or the other. The reason for this is that the ship has been designed with an initial negative metacentric height; that is, in a light position she is unstable by a small margin. When she starts to roll to one side or the other, which she must necessarily do, she finally comes to a position of stability because the listing increases the breadth of the plane of the water line or line of flotation, which greatly increases the "I" in the formula to the point where GM, the metacentric height, is greater than zero, and the list goes no farther.

When the freighter is loaded with cargo, the center of gravity being lowered, the negative metacentric height becomes positive, so that when ready for sea the vessel is stable. A ship so designed must of course be loaded with ballast to make her safe when no cargo is available.

It is advisable for many reasons that the metacentric height of a ship should not be excessive, although to the layman it might appear that the greater the metacentric height, with the consequent righting moment, the safer a ship.

There are, however, disadvantages in a ship with too great a righting moment—that is, too high a metacenter—because she will be too stiff, and will roll in a sea-way with a sudden jerky movement that is very likely to snap her masts off, besides being extremely uncomfortable for passengers and crew. An easy, gentle roll is preferable for comfort, and also better for the ship, both as regards the effect on her structure and the possibility of shifting her cargo.

An experienced naval architect, or an engineer familiar with problems of vessel stability, would have known, in the case of this particular ship, from the statement made as to her inclination to list to either side, that when unloaded her metacentric height was slightly negative instead of positive. I will not comment upon the effect of the juggling done in trying to bring her to an even keel by filling water-ballast tanks on one side and emptying them on the other; but I am quite sure that anyone who has ever tried to right a listed vessel under these conditions by juggling with the water-ballast tanks will realize how futile the effort was.

Your closing paragraph I think is misleading, because it is just as well that the general public should not know too much about the metacentric height of a vessel. "A little knowledge is a dangerous thing" and might give rise to false ideas of security, such, for instance, as those apparently held by many of the passengers during the "Titanic" disaster, and later the "Lusitania," that these great ships were unsinkable.

A 56-in. metacentric height would undoubtedly give more righting moment to the same vessel than a 14-in. metacentric height; but if the 14-in. is sufficient, this will make a much more comfortable vessel, and the passengers will not be nearly so likely to suffer the disagreeable sensations of seasickness. Furthermore, a 56-in. metacentric height, if brought about by the addition of water-ballast, may be gradually reduced, or become nonexistent, if the water-ballast tanks are only partially full. The steamship line advertising the great stability of its vessel may have neglected to consider the negative effect on the stability of the free water careening in the partly filled tanks.

I disagree entirely with your concluding statement that "there can be no doubt that stability calculations and the margin of stability of vessels will hereafter have an importance in the minds of vessel owners and builders which they have never before possessed." The design, computation and construction of vessels in the hands of those capable of being entrusted with such work have always received all the care and consideration which you rather intimate will only now be given them as a new problem. As a matter of fact it is a very old problem.

F. R. HARRIS,
United States Navy Yard.

Philadelphia, Aug. 9, 1915.

Opposition to Concrete Chutes

Sir—Under the heading of "Concrete Chuting Predominant" there appeared an editorial in *Engineering News* of Aug. 12 to which I feel it necessary to reply. The protest against a free use of chuting concrete has been reduced in volume perhaps, so far as printed objections represent volume, but from conversation with engineers I am convinced that the voices in opposition have not been reduced in number.

For a number of years I have insisted that while "wet" concrete is preferable to the old-fashioned "dry" concrete, there must be care used in the amount of water. I have held that concrete which pours readily from a wheelbarrow is not the ideal concrete. It is too easy to add just the amount of water that will hurt the material. In the olden days when dry concrete was the rule we never heard of the dusting of floors. Today with finer grinding of cement and the use of considerable water it is difficult to obtain a nondusting floor. Perhaps if fine grinding of cement had not come in about the time the excessive use of water became common there might have been less heard of unsound concrete and the dusting of concrete surfaces. The ideal amount of moisture produces a mass that is sticky and pasty rather than free flowing. Such material requires to be assisted from a wheelbarrow by shovel or hoe. It is not necessary to state that a mixture of this kind cannot be chuted.

Those who wonder at the increasing use of chutes and the great popularity of this system of delivering concrete seemingly do not take into consideration the wonderful power of advertising. The makers of chuting devices advertise them extensively. They are able to produce records of very low costs in the delivery of concrete from mixer to forms and the contractor who does not use a chute when he is permitted to do so is a foolish contractor. I would do it myself if I were a contractor and the engineer permitted the use of chutes. As an engineer I forbid the use of chutes on work of any importance where the introduction of reinforcement allows a great reduction in section and the compressive strength of the concrete is relied on to the limit. Much of the unsoundness, so-called, of concrete reported is certainly due to the use of an excessive amount of water. The only thing to be done so long as chutes are being exploited is to await results and no results worth having can be secured for two or three years to come, when some of the chuted concrete will have attained an age of five or more years.

ERNEST MCCULLOUGH.

Monadnock Block, Chicago, Aug. 16, 1915.

Paper Bags vs. Cloth Bags for shipping hydrated lime was discussed by F. E. Kessinger before the National Lime Manufacturers' Association. Mr. Kessinger is attorney for the rope-paper-bag manufacturers. Comparing the cost of the two types of bag, he stated that paper bags holding 40 lb. each can be purchased for $17 per thousand. At this rate, when used for shipping cement, the cost for the bags would be about 17c. per bbl. The cloth bags holding 100 lb. and costing about 15c. each can be used for about four trips on the average before being worn out or lost. This makes the cost of the cloth bag per barrel of cement shipped about 15c. The difference of 2c. against the paper bag, however, is claimed to be more than made up by eliminating the trouble with customers in connection with the return of bags. Mr. Kessinger stated that the railroad freight Committee on Uniform Transportation of the railroad freight authorities is for the present permitting the use of paper bags in less than carload shipments as well as in full carloads. It is hoped that this condition can be made permanent, introducing a specification for the quality of paper bags that will be acceptable.

Galveston Storm Damage

The City of Galveston is quickly recovering from the recent storm; an 8-in. main across the bay is temporarily supplying water, cleaning up of the débris along the seawall boulevard and the silt and dirt in the north side streets is practically completed and a pile trestle is in process of construction as a substitute for the destroyed causeway approaches. Advices from the city state the most hopeful spirit prevails and suggestions that Galveston's prestige as a seaport has suffered a permanent setback are indignantly resented.

FIGS. 1 TO 3. ALONG THE GALVESTON SEAWALL AFTER HURRICANE OF AUG. 16, 1915

Fig. 1—Damage to pavement and boulevard caused by overfall of water at 19th St. Fig. 2—Looking east from 25th St. Fig. 3—Damage to pavement and backfill at 23rd St.

Seawall a Good Protection

As was pointed out in last week's issue of *Engineering News* the seawall successfully protected the south front of the city against the inundation which caused most of the 1900 damage. The additional views given herewith (Figs. 1 to 3) are from photographs of the Gulf front after the storm. Fig. 2, a view at 25th St., shows the Boulevard in surprisingly good condition. Here the waters of the Gulf were baffled and the overfall was unable to obtain a hold under the backfill, which extended a sufficient distance back from the seawall to prevent damage to the pavement. At 19th St. (Fig. 1), on the contrary, the concrete sidewalk was seriously damaged, though the seawall is intact. Fig. 3 shows the damage to pavement and backfill at 23d St. At this point the seawall was temporarily undermined and the backfill was washed out with consequent serious damage to the brick pavement.

The views in Figs. 4 to 7 show remarkably well the complete destruction of the earth-fill approaches of the causeway. The bay between Galveston Island and Virginia Point on the mainland is over 10,000 ft. wide and averages about 5 ft. in depth. The causeway, which was completed in 1912, consisted of a middle section 2555 ft. long made up of 28 reinforced-concrete arches with a 100

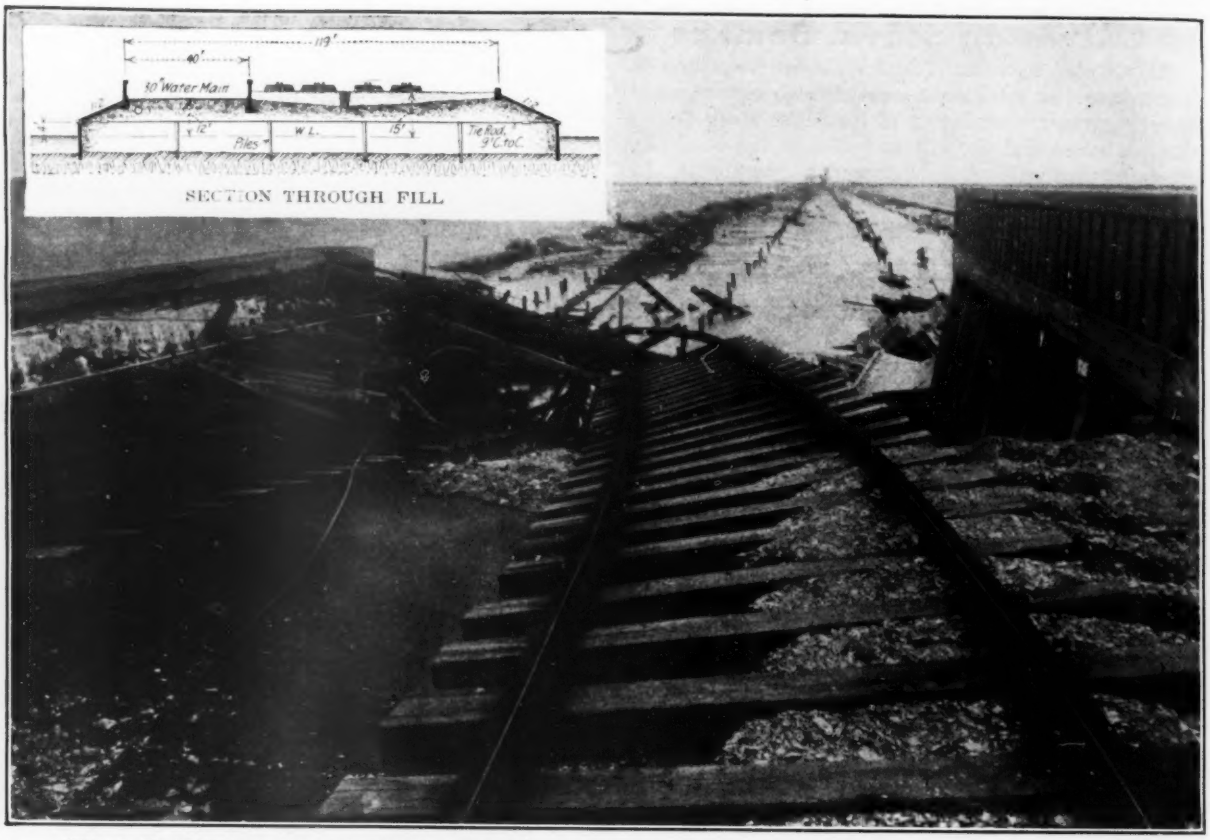


FIG. 4. LOOKING FROM EAST END OF CONCRETE VIADUCT TOWARD GALVESTON. RAILROAD SECTION

FIG. 5. LOOKING FROM WEST END OF CONCRETE VIADUCT TOWARD MAINLAND. BRICK-PAVED ROADWAY WHERE PROTECTED FILL BEGAN

FIG. 6. LOOKING FROM EAST END OF CONCRETE VIADUCT TOWARD GALVESTON. ROADWAY SECTION

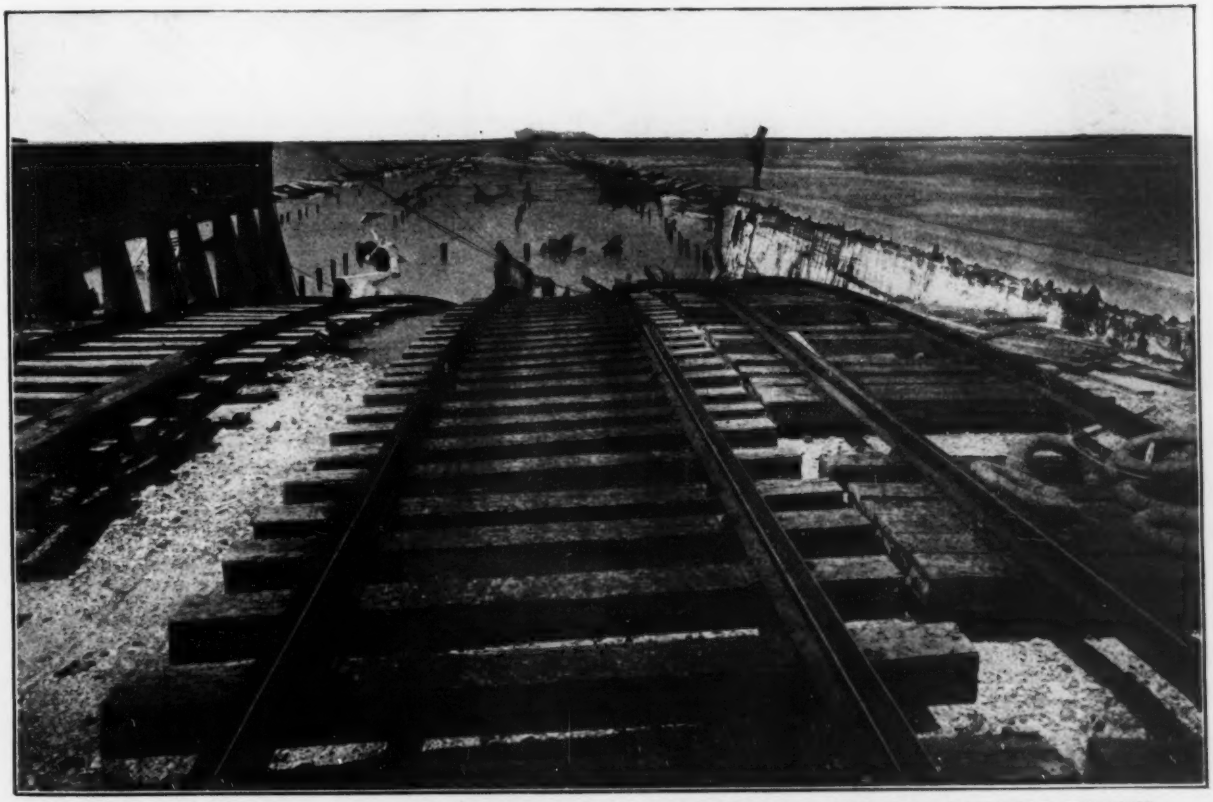


FIG. 7. LOOKING FROM WEST END OF CONCRETE VIADUCT TOWARD MAINLAND. RAILROAD SECTION. VIRGINIA POINT IN DISTANCE

ft. bascule, and two approaches of similar design, 3697 ft. long on the Galveston side and 4523 ft. long toward the mainland. The arch section and the bascule remain today practically as they were before the storm, except for the damage near the ends. The approaches, on the other hand, are destroyed as approaches although, as the views show, a large part of their structure remains.

The sketch in Fig. 4 gives a section through the approaches to the causeway. Briefly, the structure is an earth fill retained between a continuous row of tight reinforced-concrete sheetpiles and protected on its slopes with a continuous pavement of 6-in. concrete slabs. The sheetpiles were tied together every 9 ft. by tie-rods which rested on light wooden piles. The roadway was divided into two parts by a balustrade, one one side being a paved highway and on the other a sand-filled and ballasted railway carrying four tracks. Under the roadway ran the 30-in. water main. The views, taken from both ends of the concrete section, show the earth fill to be washed away, there remaining only the torn-out slabs and the light piles supporting the now useless tie-rods. As was to be expected the back-wash tore out a part of the fill and roadways over the last arches of the concrete part of the causeway.

Causeway Approach Design Faulty

An interesting comment on the design of the earth fills across Galveston Bay has been received from Wilmer Waldo, an engineer, of Houston, Tex. Mr. Waldo says in part:

"Economy may have dictated to the engineers engaged in the design of the Galveston Causeway, but even if it did much light-hearted confidence in the elements ruled somewhere in the councils of those in authority. The bare fact is that the design of the greater part of the causeway did not justify the evident confidence reposed in it.

"The central portion, that is, the arches and lift span, withstood the power of the storm as was to be expected, both being practically standard construction, but the balance of the structure at each end, about two-thirds of the whole, collapsed like an empty barrel with the hoops removed.

"The weakness in the protected roadway was not a theoretical one. It was visible to any layman who took the trouble to examine the construction. It required no technical demonstration to prove such weakness, especially to anyone who went through or who had observed the effects of the storm of September, 1900. Today the bulkheads of concrete piles forming the container for the filled roadway are standing and the water inside the bulkhead is somewhat higher than the bay level outside, showing that this part of the construction was tight and is tight yet. The fill above the level of the bulkhead, protected on its slopes with reinforced-concrete slabs had no more chance to stand than any other sand or earthen dump built in an exposed position.

"I was on the causeway at 5 p.m. Monday, Aug. 16, in order to make some observations in connection with the suspected weakness of the filled portion. Even at that hour the weather was very thick and it was growing dark, but the water could be seen piling up against the east side of the causeway and the wind and water were lashing the ballast from under the tracks. It seems that the pressure against the fill was enough to push it out bodily when once it was weakened under the protecting slabs. At any rate the storm continued long enough to eat the fill away gradually and drop the slabs into the bulkhead.

"Properly filled with rock, this work would have cost a few hundred thousand dollars more and would now require the mere relaying and ballasting of tracks in order to operate trains. It has been rather costly experience where none was necessary."

Conditions After the Storm

Further word from R. P. Babbitt, who went to Galveston immediately after the storm at the request of this journal, gives some details of the conditions in the city:

"The seawall prevented a repetition of the 1900 disaster for it broke the force of the waves and the demolition of buildings was confined to a comparatively small area along the Gulf front. The waters of the Gulf driven by the wind swept around the city and backed up in the bay to the northeast, gradually submerging the city streets to an approximate depth of 6 ft., choking the sewers with sand and silt, and putting the gas mains and electric-light system out of commission. The 30-in. water main which supplied the city with fresh water from the mainland was broken when the approaches to the causeway were washed away. A second water main which paralleled the causeway on the bottom of the bay was also broken, cutting off completely Galveston's water-supply. The people of the city suffered considerably from a lack of drinking water. Some of the more destitute dipped water from the gutters and other stagnant pools and attempted to subsist on this. For several days the luxury of a bath was denied and in fact it was difficult to obtain fresh water in which to wash one's face and hands. The food supply of the city ran low, and the people were placed on short rations, consisting principally of canned stuff.

"Practically every retail establishment in the business district of the city was flooded by the ocean that backed in from the bay. Thanks to the seawall, the waves did not roar through the streets of the city as they did in 1900. When the pressure of the Gulf waters crowding into the bay was relieved, owing to the cessation of the wind, the waters in the city streets subsided, leaving a coating of sand and silt behind in the stores, on the walls of the buildings inside and out and on the streets and sidewalks.

"The telephone system, which had been put out of commission by the storm, was partially resumed by installing an automobile engine in the telephone-exchange building and connecting up 1200 phones throughout the city. The Galveston *Tribune* resumed operations, driving its presses by motor-truck power, connecting its press with the rear wheel of a truck and getting out its issues regularly."

The New York Fire Department in 1914—Fire Commissioner Robert Adamson, of New York City, in a report to the Mayor states that there was an increase of 52½% in the number of fire-prevention orders complied with and 29½% in the number issued. A lawsuit was won which established the fire commissioner's right to recover the cost of extinguishing a fire due to "culpable and willful negligence." The total number of fire alarms received was 16,245, of which 1820 were false alarms. The total fire loss was $8,217,811, an average of $464 for a fire. In 1913 the loss was $7,467,911 in a total number of 12,598 fires. The population increased in this city in 1914 by 216,000. The Fire Marshal's Bureau reported 173 incendiary fires for the year. This was only a small part of the actual number of fires of this character. There were 50 arrests for arson and 37 convictions. The gradual passing of the fire horse is emphasized by a reduction of 174 last year; 1167 remain. Contracts were let for 76 pieces of motor apparatus to take the place of the horses retired.

Quebec Bridge Work in 1915

At the beginning of the 1915 working season the condition of the St. Lawrence Bridge Co.'s work on the Quebec Bridge was as follows: On the north side the anchor arm was only partly erected, nearly two panels not yet having been set; on the south side the approach spans were up, but nothing had been done on the anchor arm, not even the falsework being started.

By the latter part of August the north anchor arm had been completed and three panels of the cantilever arm erected, as Fig. 1 shows. On the south side the anchor arm falsework had been put up, the floor placed, the lower chords completed, and three panels of bottom posts and lower diagonals placed.

Progress on the north side is slightly ahead of schedule. Comparing this year's work on the south side with last year's work on the north, the 1915 work is eight weeks ahead.

The north cantilever should be completed this season, whereupon the traveler will be taken down, transferred three miles downstream to Sillery, and reërected (in part) for the construction of the suspended span. The foundations for the falsework on which the latter is to be erected are now going in. By the time the south cantilever is finished, in 1916, the suspended span ought to be fully erected and ready to be moved and hoisted into place in the bridge. Thus the bridge may be in service at the close of 1916—a season ahead of what was thought probable.

FIG. 1. PRESENT STAGE OF ERECTION OF QUEBEC BRIDGE

North cantilever arm three panels out; south anchor arm about half erected, two months ahead of last year's work on north anchor arm

In speed of erection the contractors have made a notable record. A specially high performance was the erection on the south shore of 1,240,000 lb. (bottom chords and laterals) in one week in July, and a total of 10,040,000 lb. for the month, in addition to transferring the interior falsework and setting the main-post shoes.

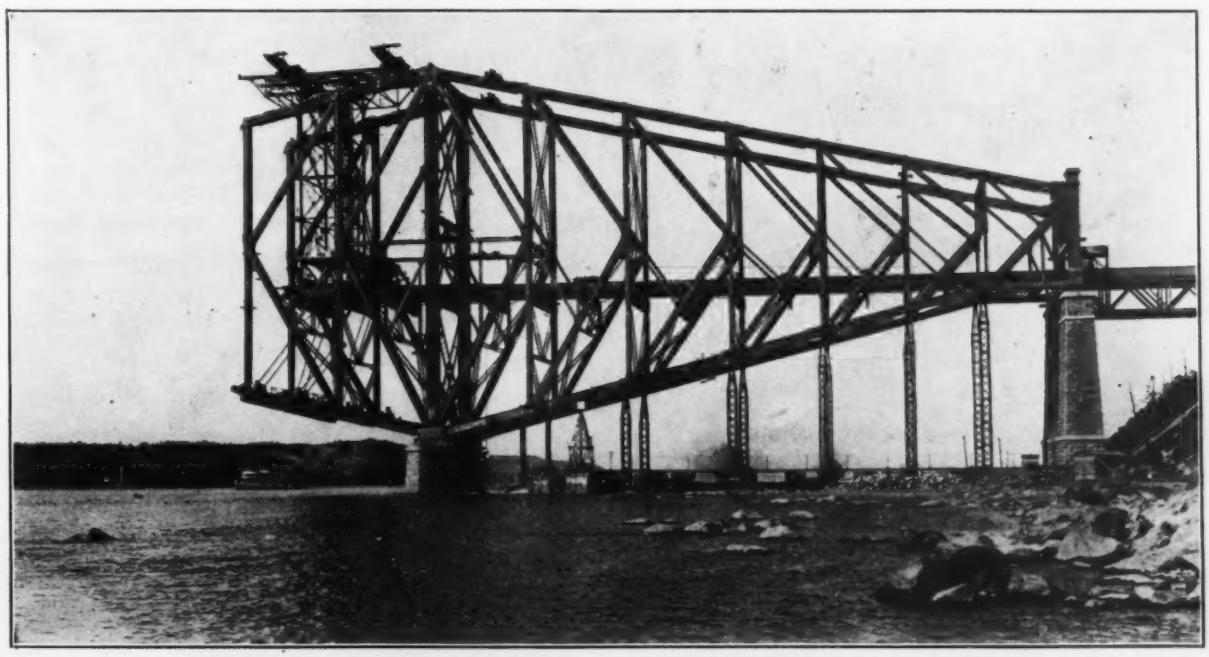


FIG. 2. NORTH CANTILEVER ARM OF QUEBEC BRIDGE ON AUG. 3, 1915

Precision of Setting Members

This speed is attributed by the contractors partly to the general design and largely to the excellence of the shopwork. Every connection is fully assembled in the shop. The bottom chord members (each panel of the

bottom chord is in four parts, being split longitudinally and divided once transversely between panel points) are machine-faced when fully assembled, and special attention has been paid to securing uniform temperature for all four webs. By the scheme of field erection for the chord, perfect bearing has been secured in every joint—not even a "feeler" being admitted.

The north shore main posts were set to a measured length only 0.002 ft. greater than the 292 ft. height between pin centers top and bottom, although of course such accuracy was accidental. This post was in 24 pieces and weighed 3,000,000 lb.

Particular effort has been made to have in the shop only work demanding accuracy. Rougher work, such as some of the falsework fabrication, was sublet.

Joining Large Compression Members

The bottom-chord erection scheme of G. F. Porter, Construction Engineer of the St. Lawrence Bridge Co., has worked perfectly. This is illustrated by the views

FIG. 3. ERECTING THE FOUR-PIECE MEMBERS OF THE BOTTOM CHORD ON FLYING BRIDGE

Figs. 3 and 5, taken on the north cantilever arm. A flying bridge projecting forward from the finished work is set just under the location of the chord to be set; it is hung by suspension rods from pins in temporary brackets attached to the web members. The quarter sections of the bottom-chord member are lowered into place on jacks, and the top flanges of the abutting sections are connected by temporary brackets, pins and links. Then lowering with the jacks throws the whole joint into full bearing, so that the bolting and riveting can be done.

Sunshine on the outer webs has frequently made a difference of a few thousandths of an inch in the bearing of these chord joints, but the riveting has been started if the difference did not exceed 0.012 in. In all cases the discrepancy disappeared as the riveting proceeded.

On the anchor-arm, instead of using the flying bridge, floor-beams are set longitudinally on the outer falsework to support the sections of the bottom chord. The whole anchor-arm chord is erected straight, from anchorage to main post, and after riveting all splices the falsework column jacks are lowered to give the proper camber

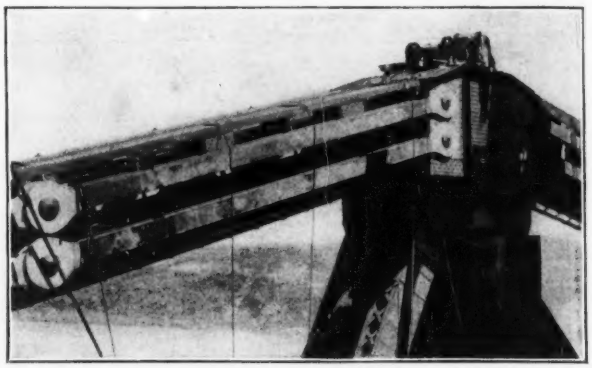


FIG. 4. THE DOUBLE EYE-BAR CHORD AT MAIN POST TOP

(about 6 in.). The cantilever arm is erected with the proper slight camber in each panel, and this flattens out under the increased load as the erection proceeds.

With three cantilever panels nearly completed, the effect of lifting on the anchor arm just begins to be appreciated. A rise of about $\frac{1}{16}$ in. is apparent at the first four panel points. This is not a lifting off the falsework, but merely a decrease of the compressive shortening of the falsework columns.

Moving the Traveler

Moving the traveler forward is accomplished as follows: The traveler cranes are run back, which eases up on the front truck springs. The erection brackets (bolted to the ends of the track girders to distribute

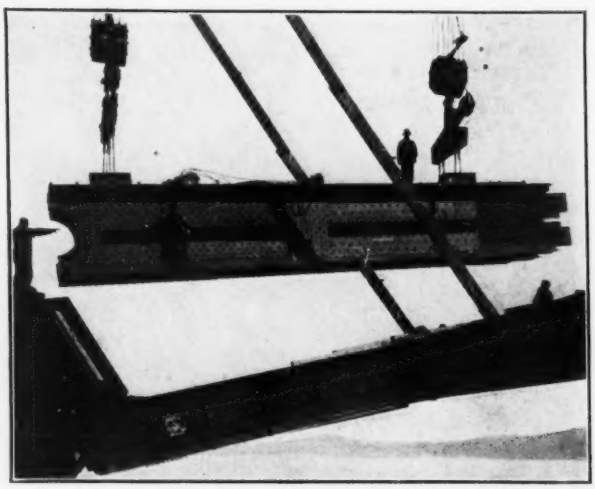


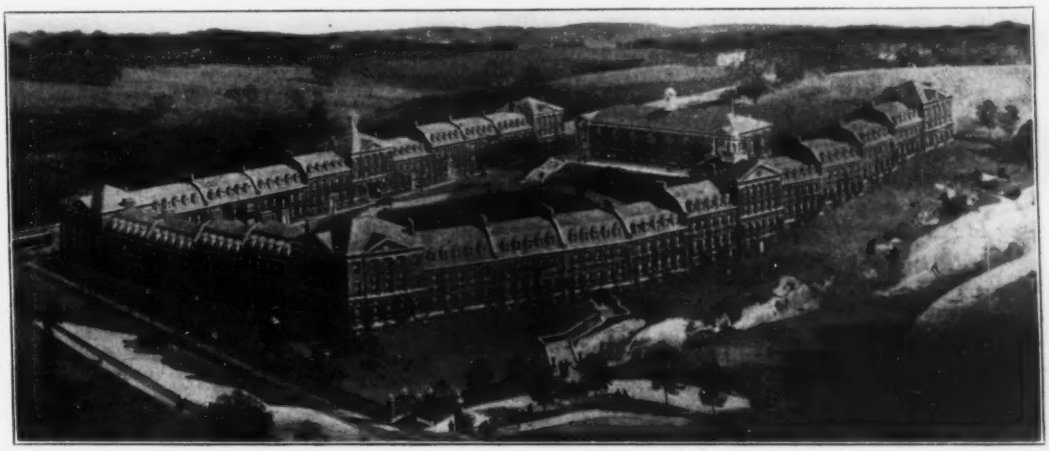
FIG. 5. SWINGING ONE OF THE BOTTOM CHORD PIECES INTO PLACE

the traveler load on two floor-beams—these being designed for only half the traveler load) are then taken off, which allows the setting of the new forward stringers track. The traveler is moved forward on the new length of track, the cranes being moved forward as the traveler

advances so as to distribute the load over the front and rear trucks. When the front of the traveler comes above the next pair of floor-beams ahead, pedestals are mounted on these floor-beams, and the traveler shimmed up on the pedestals by manipulating the cranes, thus cutting the truck springs out of action and getting a rigid bearing.

New Buildings in Rensselaer Polytechnic Institute

Construction of a dining-hall and six initial units of a dormitory quadrangle for the Rensselaer Polytechnic Institute at Troy, N. Y., is now under way. As shown in the accompanying view, there will be 27 separate dormitory units, built about three sides of a court, east of the gymnasium and athletic field and adjacent to 15th St. and Ave. B of the City of Troy. Across the end of the court will be a dining-hall accommodating about 400 men. All the buildings will be of Harvard brick, with limestone trimmings, and of fireproof construction, the floors and partitions being of brick and concrete.



PROPOSED DORMITORIES AND DINING HALL; RENSSELAER POLYTECHNIC INSTITUTE, TROY, N. Y.

Each separate unit of the dormitory system will house twelve students, four on each floor. Two students will use one study and each man will have a separate bedroom. There will be a bathroom on each floor.

Six of the units will be larger than the other 21, the larger ones costing $16,000 apiece and the others $12,500.

A. T. White, of Brooklyn, N. Y., has given the sum of $50,000 for four units of the dormitory, and Capt. Robt. W. Hunt, of Chicago, $16,000 for one of the larger units, which will contain the main entrance to the group. Mrs. Russell Sage has given $100,000 for the dining-hall.

Air Analyzer for Determining Fineness of Cement

Experiments during the past three years at the United States Bureau of Standards have resulted in the development of an air-analyzer which is claimed to give results superior in accuracy to the sieve methods prescribed for the determination of cement fineness. For some time it has been felt that the variation in sieve results obtained under the standard methods is entirely too great for practical purposes. The mechanical construction of the sieves does not seem to be constant, and the method of operation can be varied to give different results.

The device is described in detail in "Technologic Paper No. 48," which may be obtained from the Bureau of Standards, Washington, D. C. It is described as follows:

This apparatus consists of a vertical brass pipe about 3 in. in diameter and 5 ft. long, at the lower end of which is attached a glass bulb in which the cement to be tested is placed. Air at constant pressure is blown into the cement through a glass tube or nozzle in the side of the bulb, and as the air can escape only through the vertical stack, it carries with it the cement dust, which is caught in a flannel hood surmounting the stack. The air flow in the stack is very uniform, and in a short time all the dust will be removed from the cement, leaving a granular residue in the glass bulb. This residue is weighed, and the amount of dust is determined by subtracting the weight of the residue from that of the original sample of cement.

Different grades are obtained by using different-sized nozzles, and thus a number of separations can be made in the very fine portion of the cement. With the aid of the microscope the size of the largest particles in any given separation can be readily determined, and in this manner the apparatus is standardized without reference to the size of the nozzles and other parts of the apparatus or the air pressure used.

It has been found that the cement "flour," that is, the portion of cement which contains no perceptible grit when rubbed between the fingers, consists of particles less than 0.0007 in. in diameter.

The apparatus may be used for separating and grading any hard-grained materials, such as ground quartz, emery and other abrasives. The air-analyzer in modified form is also capable of separating many other powders; for example, paint pigments, plasters, clays and similar materials.

The Cement Trade of Australia has not interested the United States greatly, on account of the high freight rates compared with those from England and Scandinavia. The Interstate Commerce Commission has been investigating this industry in Australia, and finds that in 1913, the last year for which full statistics are available, 200,000 tons of cement were produced in Australia, and 124,100 tons were imported. The average wholesale price per cask of 400 lb. was $3.04 with duty paid, the duty during that period being 18c. per 112 lb. for cement from England, and 24c. per 112 lb. from other countries. The imports were distributed as follows: England, 31,000 tons; New Zealand, 2700; Germany, Austria and Belgium, 81,000; Scandinavia, 9000; United States, 400. The local production was divided among five factories—two in New South Wales, with a capacity of about 145,000 tons; two in Victoria, with a capacity of about 38,000 tons; one in South Australia, about 17,000 tons. According to Commercial Attaché William C. Downs, Melbourne, the effect of the war on the cement situation was to raise the price to $5.48 per cask; it then dropped to $4.38, varying thereafter from this figure to $4.87. Contracts for cement at the last figure have been placed in Scandinavia and Japan. Freight rates from Norway and Sweden are reported to be from $8.52 to $9.73 per ton.

News of the Engineering World

Phenomenal Rise in the Meramec During Recent Flood

The rain of Aug. 19-21 in the St. Louis district caused disastrous floods in the Meramec River to the south and west of the city, the greatest damage probably occurring at Valley Park, about twenty miles to the southwest. The total drainage area of the Meramec is 3619 sq.mi.; at Valley Park it is probably 3530 sq.mi. The valley extends about one hundred miles in a straight line above Valley Park and the length of the river through that stretch measured along the thread of the stream is probably over two hundred miles. The drainage basin is rugged and hilly and comparatively thinly populated.[1]

The town of Valley Park is built on a level about 30 ft. above ordinary low water in the river and has never before been seriously damaged. There are a number of industries located at this point, the principal one of which is the Valley Park Glass Co., and above the town on both sides of the stream summer camps and club houses are located.

According to the best reports the river rose about 7 ft. on the night of the 19th and about 17 ft. additional on the 20th. It was practically stationary during Saturday the 21st and it was generally assumed that the high water had been reached, but during the night of the 21st and the day of the 22nd an additional rise of 19 ft. occurred, making a total of 43 ft. above low water. This submerged practically the whole town well above the ordinary second-story level, and a large part of the rise having come during the night, it appears that a majority of the people were marooned in their own houses. As far as can be ascertained, however, no lives were lost, but the damage to the property has been enormous.

This stage of the Meramec was probably partly a result of the condition of the Mississippi River, into which the former discharges twenty miles below Valley Park. The Mississippi rose from a gage of 22 on Thursday to a gage of 30 on Sunday, which is danger line.

[1]See discharge measurements in water-supply papers of the United States Geological Survey, Vol. 7, No. 10. Progress report of stream measurements for the calendar year 1904, Part 8.

Bids for Albany Sewage Pumps and Grit Chamber

Bids for a 75,000,000-gal. automatically operated electric sewage-pumping station and for a large grit chamber will be received by the City of Albany, N. Y., on Sept. 7. The pumps will work under a maximum head of 39 ft.

The pumping equipment will consist of six vertical centrifugal pumps each direct-connected to a vertical motor. Three of the pumping units will be operated by 2200-volt constant-speed alternating-current motors, each unit having a capacity of 10,000,000 gal. in 24 hr. The other three units will be operated by 575-volt variable-speed direct-current motors, each of these units being designed to pump from a minimum of 5,000,000 to a maximum of 15,000,000 gal. in 24 hr.

In a number of ways the pumping station is somewhat unusual in design. The pumps are located in a circular dry well, an annular well outside of the dry well being utilized to serve as the suction well. Unusual care has been taken in designing the station to provide easy access to all parts of the mechanical and electrical equipment and especial arrangements have been made to prevent deposits in the suction well.

The grit chamber is believed to be the largest one of its type yet designed in this country. Special means are provided for maintaining a practically uniform velocity through the grit chamber with a wide range of sewage flow.

The pumping station and grit chamber, as well as the sewage-disposal works which are now under construction, were designed by Hering & Gregory, Consulting Engineers, New York. Wallace Greenalch is Commissioner of Public Works, Frank Lanagan is City Engineer and Stephen B. Vernon is engineer of intercepting-sewer design and construction.

Am. Soc. C. E. Admission Rules

The Board of Direction of the American Society of Civil Engineers has recently adopted by letter ballot the following rules to be applied in interpreting the society's constitutional requirements for the admission of new members:

The requirements fixed by the constitution are intended to mark the minimum which should be recognized for admission to membership, and the maintenance of a high standard necessitates that these provisions should be interpreted conservatively to the end that the fitness of applicants shall be established beyond doubt.

In order to shape more definitely the requirements in the classification of applicants for admission or for transfer, and to assure as far as possible that applicants for membership meet the spirit of the requirements established by the constitution, it is the sense of this board:

1. That no applicant should be admitted to any grade whose qualifications do not clearly exceed the minimum requirements of the constitution.

2. That each applicant for admission or for transfer shall furnish whenever possible, the names of persons, whether members of the society or not, who have personal knowledge of his work in each of the positions enumerated in his application and when possible shall have more than five references, and his application shall state in detail the character and extent of the works upon which he has been engaged, and the degree to which he was responsible for their design and execution.

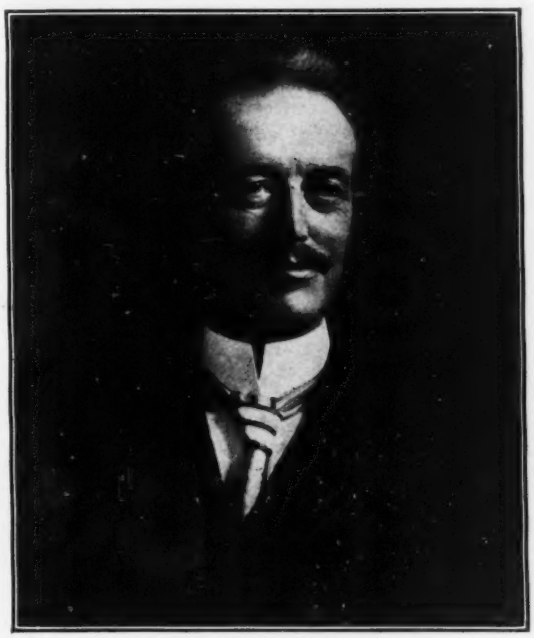
3. That an applicant for membership or for transfer who, at the time of making his application is engaged on work for which an engineering education or training is not clearly essential, shall not be elected or transferred unless he shall have markedly superior qualifications as to professional experience.

4. That the professional work required for admission to the grade of member shall be of a markedly higher order, and the degree of responsibility materially greater than for the grade of associate member.

5. That unless a candidate is eminently qualified for the highest grade, admission to that grade should be by transfer from the grade of associate member.

Dexter Brackett*

Dexter Brackett, Chief Engineer of the Metropolitan Water-Works of Massachusetts, died at his home in Brighton, Mass., on Aug. 26. He had been in poor health since last February, but the severe illness which resulted in his death was short. He was born in Newton, Mass., in 1851 and in 1868 was graduated from the Brighton high school near Boston. The next year he entered the city engineer's office, Boston, where he remained for 26 years. In 1874 he was assigned to the supervision of the distributing system of the water-works. In this position he was largely instrumental in developing an unusually adequate piping system for the city and in creating a plant exceptionally efficient in other respects.



DEXTER BRACKETT

In 1895 he resigned his place with the City of Boston to accept the position of engineer of the distribution department of the Metropolitan Water-Works. In this capacity he had charge of the construction of the pipe system, pumping stations and distributing reservoirs within the limits of the Metropolitan District.

From 1907 to the time of his death, Mr. Brackett was Chief Engineer of the Metropolitan Water-Works. He had always been greatly interested in questions relating to the consumption and waste of water and had written several papers and reports upon the subject. He persistently advocated the use of meters within the Metropolitan District as a means for reducing the waste of water, and had the privilege of seeing his views adopted and the consumption of water thereby reduced. Up to 1907 the consumption had been increasing so rapidly as to point out the necessity for an additional supply within a few years, but the gradual introduction of meters reduced the consumption of water so rapidly that no additional supply will be needed for many years, the consumption now being less than two-thirds of what it would have been had the rate of increase continued. Mr. Brackett was a member and for three years a director of the American Society of Civil Engineers. He had been president of the Boston Society of Civil Engineers and of the New England Water-Works Association, and was a member of the American Water-Works Association. In addition to his papers on consumption and waste of water, he contributed papers on many other subjects relating to water-works engineering. He was married in 1875 and leaves a widow and a son, Herbert D. Brackett.

*Contributed by Frederick P. Stearns, Consulting Engineer, Boston, Mass.

Novel Protest Against a Dam

Three engineers testified against the safety of dams, at a hearing on a water-supply dam being built for Coatesville, Penn., held at Harrisburg on Aug. 24, 1915, before the Pennsylvania Water-Supply Commission. The hearing was on application of mill owners in Coatesville, who want the permit for the dam to be revoked. The three engineers testified in their behalf.

Health Commissioner Samuel G. Dixon took the lead in conducting the hearing, as he has been the chief figure in ten years' work to secure a new water-supply in place of the polluted and dangerous raw river supply which Coatesville borough now enjoys. He referred repeatedly to the 1912 typhoid epidemic in the borough, when over 300 deaths occurred, and demanded that the protest should take the form of a definite project for securing another supply without delay. The protestants made a general proposal for a dam in another valley.

The protested dam is already under contract. It is to be a hollow concrete structure 35 ft. high, on granite foundation, and crosses Rock Run 2 mi. above the borough. Half a dozen mills are in the valley below; the owners claimed that failure of the dam would sweep away their mills. The protest was made in the name of Worth Bros., the Lukens Iron & Steel Co., the Coatesville Boiler Works, Craig, Ridgeway & Sons Co., and some 1300 individual signers of a petition. The population of the borough is 12,000. The mill owners urged that this population depends on the mills, and that the mills would be driven away if the dam were built. They proposed that another stream, Buck Run, be dammed, which could affect only a village of 100 houses. The mill owners have previously made many efforts to kill off the Rock Run project, including several court actions, which failed.

The engineers' testimony, abstracted from notes made by a representative of *Engineering News* at the hearing, was as follows:

E. P. Dawson, Assistant Chief Engineer, Philadelphia & Reading Ry.—Failure of the Rock Run dam would flood the valley for a long distance, damage much property, and possibly cause loss of life. He has not studied the plans or considered the strength of the dam. His protest, for the railway company, is based wholly on the location of the dam.

Maj. Cassius M. Gillette—The failure would cause more appalling destruction than the Austin (Penn.) dam failure. The Rock Run site is good and the specified foundation is good, and a good dam can be erected. A dam built strictly to the design and specifications would be "a good dam as dams go." An earthquake even would probably not destroy it, but dynamite could do so. There is small risk in a well-built dam. The chief danger is from violence. German emissaries could destroy all plants in the valley by dynamiting the dam. Strikers could do the same. However, if abandoning the Rock Run site means indefinite delay in providing a new water-supply, he favors the dam. Typhoid is more of a menace than the dam.

Herbert W. Hatton, Wilmington, Del.—Many dams fail; 18 dams failed in 1912, many of them in Pennsylvania, the smallest being 15 ft. high. He has no criticisms of the design, but thinks it would be safe. However, dams fail from causes not anticipated. Even rock foundation is not a guarantee of safety; the Stony River Dam, of the same type as that proposed, was on rock.[1]

Dr. Dixon shut off further testimony on the risk remaining in dams built with best engineering skill, by the statement that bridges could not be built or railways run on the principle that perfect safety must be provided, free from every possibility of accident.

The Water-Supply Commission has not yet announced its decision on the protest.

A Tunnel Cave-In occurred in the 15-ft. sewer under construction between Macon and Halsey St., Brooklyn, N. Y., Aug. 26. The collapse is reported to have been caused by the failure of the shoring. One man was killed and two injured.

A Bridge Collapsed under a passenger train on the Atchison, Topeka & Santa Fé Ry., Aug. 27. The bridge was over Date Creek, 70 miles north of Phœnix, Ariz., and had been weakened by a recent flood. The engine passed over the bridge safely, but the smoking car fell through, causing the death of four persons and injuries to twelve others.

The Explosion of a Tank Car of Gasoline in the Westchester freight yards of the New York, New Haven & Hartford R.R. on Aug. 23 destroyed five other carloads of freight. More than a dozen cars were set on fire by the burning oil. The damage was estimated at between $50,000 and $55,000. The cause of the explosion is unknown.

The St. Paul Union Station is temporarily held up following a second rejection by the Chief of Engineers, Gen. Don. C. Kingman, of the submitted plans for the changes in the Mississippi River channel and harbor lines at and about the new station. These plans were submitted by the railroad companies building the station. General Kingman's memorandum accompanying the returned plans makes it clear that the revisions must be made more with a view to improving the navigability of the river than to accomodating the needs of the station. Any new scheme submitted will evidently have to come through the city authorities and will have to guarantee a better accommodation for freight transshipment. The proposed station was described in "Engineering News," Mar. 11, 1915.

United States Leads in Exports—According to the Department of Commerce the United States for the first time in its history leads the world as an exporter. Our total exports in the fiscal year 1915 aggregated $2,768,600,000, as against $2,170,100,000 for the United Kingdom, the figures representing in the case of the United States an increase of 17 per cent. and in the case of the United Kingdom a decrease of 30 per cent. when compared with last year. American exports in the fiscal year 1915 included domestic products to the value of $2,716,200,000, against $2,329,700,000 in 1914; and foreign products, $52,400,000, against $34,900,000 in the preceding year. British exports in the same periods included British and Irish produce, $1,744,100,000 in 1915, against $2,557,200,000 in 1914; and foreign and colonial produce, $426,000,000 in 1915, compared with $526,500,000 in 1914.

An Excursion of Engineers through western Canada, in connection with the International Engineering Congress, has been arranged by committees representing the members of the principal British, Canadian and American civil engineering societies who reside in British Columbia and Alberta. A special excursion train is to leave San Francisco Sept. 25 for Seattle. The passengers will travel from Seattle to Victoria by boat, and after a day spent in sightseeing at Victoria will leave for Vancouver on the morning of the 28th. Here two days will be spent in visiting water-power plants of the British Columbia Electric Ry. Co. and other engineering works. The special train will start from Vancouver eastward over the Canadian Pacific on Thursday, Sept. 30. Stops are scheduled at Ruskin, to see the plants of the Western Canada Power Co., and at Glacier, where the seven-mile tunnel now being driven through the mountain by the Canadian Pacific Ry. will be visited. Sunday will be spent at Lake Louise. Further stops at Seebe, Calgary, Bassano and Brooks are scheduled.

[1]This dam, which failed Jan. 5, 1914 (see "Engineering News," Jan. 22, 1914), was distinctly not founded on rock. It had a cutoff wall reaching shale over a part of its length, but the section that failed was founded on clay.—Editor.

PERSONALS

Mr. Vannoy H. Manning, M. Am. Inst. M. E., Assistant Director of the United States Bureau of Mines, has been appointed Director to succeed the late Dr. J. A. Holmes.

Mr. Robert A. Zentmyer, a civil engineer of Tyrone, Penn., has been appointed a member of the Pennsylvania State Water-Supply Commission at a salary of $3000 per annum.

Mr. Samuel Rea, M. Am. Soc. C. E., President of the Pennsylvania R.R., is seriously ill at the Polyclinic Hospital, Philadelphia, where he was taken about two weeks ago for a minor operation.

Mr. William C. Pickersgill, for the past nine years Assistant Engineer of the Board of Water-Supply of the City of New York, has been appointed Designing Engineer of the Providence, R. I., Water-Supply Board.

Mr. C. D. McArthur has again assumed the office of Chief Engineer of the Blaw Steel Construction Co., after more than a year's absence. He is in personal charge of the engineering-service department of the company.

Mr. E. A. Moritz, Assoc M. Am. Soc. C. E., Engineer of the United States Reclamation Service, Washington, D. C., has been appointed Office Engineer of the newly established executive office of the Reclamation Service at Denver, Colo.

Mr. Harvey C. Miller, M. Am. Soc. C. E., Consulting and Contracting Engineer, formerly at 1 Madison Ave., New York City, is now agent for the American system of reinforcement (unit wire fabric, unit spirals and unit frames), with offices at 40 West 32nd St., New York City.

Mr. C. E. Hicks, who was graduated from Stevens Institute of Technology in 1876, has been appointed City Engineer of Mechanicsville, N. Y., under the new commission-plan city government. Mr. Hicks has had many years' experience in private practice at Mechanicsville.

Mr. B. F. Bush, President of the Missouri Pacific and Iron Mountain railways, has been appointed Receiver of these railways. Mr. Bush is a civil engineer by education and early experience. He entered the railway service in 1882 as a rodman on the Northern Pacific Ry., and subsequently was Locating Engineer and Division Engineer.

Mr. L. C. Fritch, M. Am. Soc. C. E., Assistant to the President of the Canadian Northern Ry., has been appointed General Manager of the lines east of Port Arthur, Ont. Mr. Fritch was formerly Chief Engineer of the Chicago Great Western R.R. He is a graduate of the University of Cincinnati and began his railway work in 1884 as a supervisor's assistant on the Ohio & Mississippi Ry.

Mr. A. J. Himes, M. Am. Soc. C. E., Valuation Engineer of the New York, Chicago & St. Louis R.R., Cleveland, Ohio, has been appointed Engineer of Grade-Crossing Elimination of the company, which department has just been restored. Mr. Himes was formerly in charge of grade-crossing elimination work in Cleveland, which was completed about two years ago. Since then he has been Valuation Engineer.

Mr. J. A. MacRae, formerly Mechanical Engineer of the Michigan Central R.R. at Detroit, Mich., has been appointed Mechanical Engineer of the Louisville & Nashville R.R., with headquarters at Louisville, Ky. He is a graduate of the mechanical engineering course of the University of Illinois and began his railway experience as a draftsman in the office of the Mechanical Engineer of the Chicago & Northwestern Ry.

Mr. John T. Beamer, of Chicago, Ill., and associates have purchased the American-Rio Grande Land & Irrigation Co., which developed the 100,000-acre irrigation project near Mercedes, Tex., claimed to be one of the largest private irrigation developments in this country. The company was organized about 10 years ago by Mr. B. F. Yoakum and others, of St. Louis, Mo. The purchase price is reported to have been $3,500,000.

Prof. Charles Lee Crandall, for many years head of the department of railway engineering and geodesy in the college of civil engineering of Cornell University, has retired from active service. Both the University faculty and the trustees have passed resolutions in appreciation of his services to the University, which began in 1872. Professor Crandall was graduated with the first class of the University in that year. He was City Engineer of Ithaca from 1870 to 1891.

Messrs. George F. Swain and John F. Stevens, M.'s Am. Soc. C. E., and W. C. Loree, former General Manager of the Baltimore & Ohio Southwestern R.R., have been appointed a commission to formulate plans for a more efficient system of port and terminal facilities for New York City. The com-

mission is appointed to serve for three years, but its estimated annual expenses of between $100,000 and $110,000 have not yet been appropriated by the City Board of Estimate and Apportionment.

Mr. E. N. Layfield, M. Am. Soc. C. E., Acting Secretary of the Western Society of Engineers has been appointed President of the new State Board of Examiners of Structural Engineers, in accordance with the recently enacted state license law for structural engineers. Other members of the Board are Messrs. John T. Hanley, Chicago, Secretary; Ira O. Baker, Professor of Civil Engineering at the University of Illinois; John W. Musham, Secretary of the Condron Co., Chicago, and C. C. Stowell, Civil Engineer, of Rockford, Ill.

Mr. Thomas C. Atwood, M. Am. Soc. C. E., former Supervising Engineer of the Yale Committee of Twenty-One, Inc., on the construction of the Yale Bowl, has opened an office in the Chamber of Commerce Building, New Haven, Conn., and in addition to his work on the Yale Bowl will engage in the general practice of civil engineering, specializing in college athletic fields and in water and sewerage works. He is a graduate of the Massachusetts Institute of Technology and has had several years' experience with the Metropolitan Water-Works of Boston, Mass., the water-works of Philadelphia, Penn., and the Catskill water-supply of New York City.

OBITUARY

Christopher Bell Bouton, President of the Union Foundry Works, Chicago, Ill., died Aug. 26, aged 76 years.

P. A. Gorman, former Street Commissioner of Waco, Tex., and a pioneer railway builder of the Southwest, died Aug. 15, at his home in Waco, aged 63 years.

William Graver, President of the William Graver Tank Works, of East Chicago, Ind., died at his residence in Chicago on Aug. 25. He was born at Chambersburg, Penn., in 1842, and went to Chicago in 1884.

Edward Bates Pleasants, Chief Engineer of the Atlantic Coast Line R.R., died Aug. 26, from apoplexy, while in his private car en route from his home in Wilmington, N. C., to Baltimore, Md. He was 65 years old and a native of Baltimore.

Max Hebgen, Vice-President and Chief Engineer of the Montana Power Co., died Aug. 24 at the Presbyterian Hospital, Chicago, Ill., aged 46 years. He was born in Milwaukee, Wis., and began his career in the shops of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Penn., about 1886. Soon after he went to Butte, Mont., where he was employed as a lineman by the old Butte Electric Light & Power Co. He remained continuously in the employ of this company through its various absorptions of other companies, and at the time of his death was Vice-President and Chief Engineer of the consolidated concerns, the Montana Power Co., which is one of the largest hydro-electric companies in the world in the extent of its developments. He was an intense worker; a man entirely self-educated. He entered his profession endowed with magnificent health, a sound intellect, a distinct inventive capacity and an unlimited capacity for hard and successful work. He was beloved by all who knew him, and it is probable that no more successful or popular officer of any corporation has existed than Mr. Hebgen, who, while occupying this position of great popularity in the organization, was also a thorough disciplinarian. His popularity was based on the profound respect which his organization held for his character, his abilities and his physical and moral courage. He is survived by a wife and one son.—H. M. Byllesby, Chicago, Ill.

ENGINEERING SOCIETIES

COMING MEETINGS

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 7-9. Convention in New York City. Secy., Willard Kent, Narragansett Pier, R. I.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual meeting in Chicago. Secy., W. O. Thompson, N. Y. C. R.R., East Buffalo, N. Y.

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

SAN FRANCISCO MEETINGS

INSTITUTE OF RADIO ENGINEERS.
Sept. 13-18. Secy., David Sarnoff, 71 Broadway, New York.

PAN-AMERICAN ROAD CONGRESS.
Sept. 13-18. Secy., E. L. Powers, Road Builders Association, 150 Nassau St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Secy., Bradley Stoughton, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Secy., J. J. Blackmore, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Sept. 17-21,

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

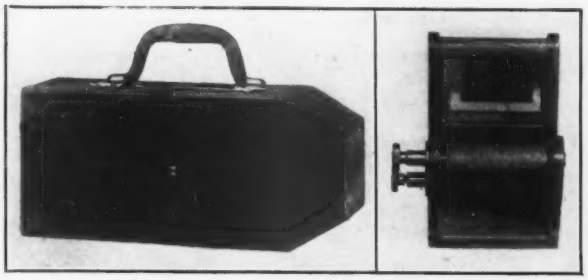
AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

New England Water-Works Association—The program for the annual convention at the Waldorf-Astoria Hotel, New York City, Sept. 7-9, includes an illustrated address by J. Waldo Smith, Chief Engineer of the Board of Water-Supply of New York, on the present status of the Catskill water-supply of the city; a paper on the sanitation of a large watershed; short papers on joints for water mains and the laying of various kinds of mains, detecting leaks, etc.; descriptions of the water-supplies of Norwalk, Conn., Salem and Beverly, Mass.; short papers and discussions on valve types and installations, testing fire-line meters and pump-slip tests; an illustrated lecture on the Kensico reservoir, New York; papers on the decolorization of water by storage, forestry work in watersheds, infiltration galleries of Long Island water-supplies, New York State control of public water-supplies, Fall River (Mass.) water-supply, grubbing a large reservoir and a progress report on service pipes. Excursions include a sightseeing trip on Fifth Ave. for the ladies, a boat trip in the harbor and an inspection of the Kensico Dam.

Appliances and Materials

Camera for Reading Meters

A camera for obtaining reliable meter readings, applicable to gas, electric and water installations, has just been placed on the market by the Eastman Kodak Co. The reading is made by placing the front of the camera against the meter dial and pressing downward on the exposure lever. This action automatically turns on light, operates the shutter and turns off the light. With this instrument mistakes of reading



THE "FACTOGRAPH" CAMERA FOR REGISTERING METER READINGS

are obviated, and in the case of a disputed reading the records are at hand. A reading of the peak on maximum-demand meters can be made before the meters are reset for the next month.

The camera measures 4¼x5¾x12¼ in., is incased in mahogany and equipped with a simple automatic shutter permitting exposures varying from ⅛ to ½ sec. Light is furnished by four 3.8-volt tungsten miniature lamps operated by two 4-cell dry batteries stored in the case. The film is 1½x2⅛ in. and of the cartridge type. Pressing a button converts the camera into a flash lamp for locating meters in dark cellars.

The "Factograph" can be leased on payment of $22.50 each. Films are supplied in spools of 75 readings per spool. These are packed in cartons of 50 spools, 10 cartons to the case. The price is $125 per case, $12.50 per carton. The dry batteries cost $36 per 100, the miniature lamps $8.50 per 100 and a desk reading stand can be purchased for $2.50.

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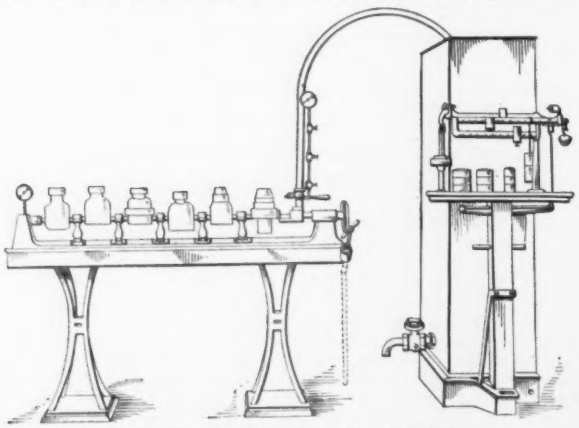
Water-Meter Tester

The outfit shown in the accompanying sketch has been devised by the H. W. Clark Co., of Mattoon, Ill., for the convenient, quick and economical testing of ⅝- to 2-in. water meters. It comprises (1) a standard-type Fairbanks scale with a special beam, (2) a 100-gal. galvanized-iron tank with quick-opening outlet valve, (3) a test table on which six



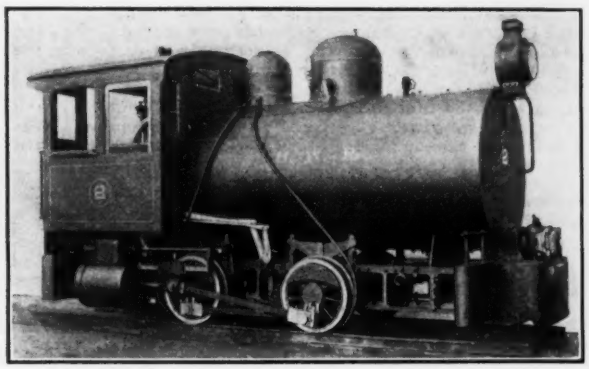
CLARK METER-TESTING OUTFIT

⅝-in. meters, or various combinations of other sizes, may be set up in series, and (4) special self-cleaning sensibility-test valves for ⅓, ½ or ⅛ normal flow. A slow-opening inlet valve is used to eliminate water hammer; gages at inlet and outlet show the loss of head through the meters. A unique feature is the percentage bar on the scale beam, showing meter error. The price ranges from $38 up.

Steam-Storage Industrial Locomotive

The fireless or steam-storage locomotive shown in the accompanying view has been put into service by the Ohio Wood Preserving Co. for switching on the standard-gage tracks at its plant. The storage tank has a capacity of 250 cu.ft. and is intended to carry a maximum pressure of 180 lb., so that no reducing valve is required between the tank and the cylinders, as in some European engines of this type which employ a higher pressure. The tank is kept about half full of water. It is recharged with steam four or five times a day from the boiler plant of the creosoting works, a boiler pressure of 150 lb. being desirable. A steam dinkey engine would have to refill its water tank about the same number of times.

The cylinders are 17x16 in., this large size being used to



STEAM-STORAGE LOCOMOTIVE FOR THE OHIO WOOD PRESERVING CO.

enable the engine to develop a fair proportion of its maximum power at low pressure. In fact, it can be run by itself on a pressure as low as 5 lb. With one charge it can run about five miles with two or three ordinary freight cars on level track. The cylinders are placed at the back end, to give a better balance. The slide valves are driven from a valve gear of the Stephenson type, and the exhaust may be discharged at rear, top or side as desired. The factor of adhesion is based on a tank pressure of 60 lb. The engine was built by the H. K Porter Co., of Pittsburgh, Penn.

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Spacers for Reinforcing Rods

A device known as the "Securo" locking spacer, for supporting concrete reinforcing rods in the forms, serves not only to support them at the proper height and give them the proper spacing, but also locks them in position so that they cannot be displaced before or during concreting. The device is a light bar passing beneath the rods and having depending lugs which rest on the bottom of the form and so keep the rods at the desired height. At the location of each rod the bar has two flexible clips which are bent around it, and these serve to insure the use of the proper number of rods. The device is made by the Metal Building Materials Co., of Chicago, Ill.

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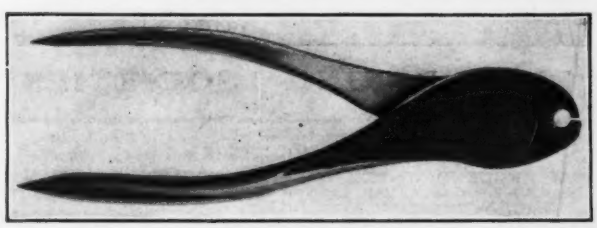
Handy Blasting-Cap Crimper

A new cap crimper, comprising the crimper proper and with the handle pointed at one end for making holes in dynamite cartridges, and shaped at the other end to serve as a screwdriver, is shown in the accompanying view. The crimper makes a cylindrical crimp of the blasting cap to the



NEW CAP CRIMPER

fuse, thus eliminating the possibility of cutting off the powder train in the fuse and consequent misfires. It also leaves a vent alongside the fuse for the escape of smoke from the burning powder inside the cap, thus allowing a stronger spit into the fulminate charge. It is manufactured by the E. I. du Pont de Nemours Powder Co.